FROM TEACHER TO DESIGNER: PROMOTING TEACHER CREATIVITY WHEN USING NEW TECHNOLOGY

by

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ABSTRACT

This dissertation study explored teacher creativity in response to new technology introduced as a consequence of an authority innovation-decision. Glaveanu's (2013) Five-A framework investigated this construct as it relates to a classroom environment, while the Concerns Based Adoption Model considered a teacher's progress toward a meaningful change in practice. As a result, a professional development program designed to promote teacher creativity when using new technology took place at an urban middle school in Connecticut. The program tasked teachers with producing a creative outcome using a new application from the G-suite. A mixed-methods study examined the impact of this program on teacher creativity, which used Kaufman and Beghetto's 4-C model of creativity as a guide to evaluating the outcomes produced as a result of participation in the program. The study also used the CBAM stages of concern questionnaire and a creativity survey to compare and measure attitude changes. The study's findings revealed teacher attitudes toward the concept of teacher creativity, a potential benefit of problem-statements when addressing ambiguity concerns, and environmental barriers that impact the production of creative outcomes using new technology. The dissertation also discusses significant challenges experienced during the implementation of the program and ideas for research related to teacher creativity and new technology.

Dissertation Adviser: Dr. Jonathan Plucker

DEDICATION

I dedicate this dissertation to my wife and children. Without their support, I would not have completed this journey. From one perspective, pursuing a doctorate program while my boys were so little was a selfish act that took away pressure time to play soccer, make Legos, and watch movies together. However, from another perspective, I hope this work will build a foundation that can benefit them in the future.

Unfortunately, words cannot adequately express gratitude to my wife, who held up the fort for three trying years. During the long hours on my computer, you made sure I didn't miss a meal and forced me to take important breaks during study. When I felt it wasn't possible, you told me I'd find a way through the storm. Your belief in me spurred me forward, and this dissertation only exists because I had you by my side. Thank you.

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Rarely does a single individual produce a body of work alone. Whether small or large, many people have helped me along the way. My colleagues at work have offered much support when needed; the teachers who worked with me volunteered their precious time, and my fellow students have made themselves available for much-needed advice. However, there are a few people who I'd like to highlight in particular; first, James Diamond and Tim Green, who served on my dissertation committee and provided valued feedback throughout my journey. I'm also grateful to my Executive Sponsor, who provided me with an opportunity to conduct my study at their school. Without this support, I'm not entirely sure I would have accomplished what I set out to achieve. Finally, I must acknowledge the unwavering support of my dissertation advisor, Jonathan Plucker, who endured many random acts of panic during my intervention. I also valued our conversations on creativity, design thinking, and the various frameworks explored during this study. I hope they continue long into the future.

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Chapter 1: Introducing Teacher Creativity

The technological tsunami of the later twentieth and early twenty-first century has ushered in new opportunities for learning. In response, significant investment has been made to increase access and use of digital technology in school (Brawner & Allen, 2006; Dolan, 2016; EdTech Efficacy Research Academic Symposium, 2017; Roblyer & Kesnick, 2003). This effort has engaged industry, education, and government, in a collaborative march toward technology integration propelled on the assumption that: (1) technology is a transformational agent that can change how students experience formal schooling (Blackwell, Lauricella, & Wartella, 2014; Curwood, 2014); (2) technology can improve student engagement (Schindler, Burkholder, Morad, & Marsh, 2017; Sukanlaya, Connor, & Ali, 2017); and (3) improved technology skills is a necessity for today's economy (Kenney & Zysman, 2016; McLeod & Shareski, 2018; OECD, 2018; OECD, 2019). The outcome of this combined effort has not only increased student access to computers, the internet, and tablet devices in school (Dolan, 2016; Graafland, 2018; OECD, 2019), but established technology as a sustained player in future visions for public education (Cheung & Slavin, 2012; U. S. Department of Education, 2017).

Nevertheless, despite billions of dollars invested in technology and technology training for teachers (Morrison, Ross, & Cheung, 2019), many schools are not receiving a suitable return on investment when it comes to articulating the level of change obtained as a consequence of new technology (Cukurova & Luckin, 2018; Zheng, Warschauer, Lin, & Chang, 2016). Research into this shortcoming has explored the procedures for procurement (Morrison et al., 2019), as well as methods used – or not used - to evaluate the impact of technological innovation in schools (Kirkwood & Price, 2013; 2014;

Rohanna, 2017). However, even if these two elements are improved, the likelihood of valued change in the classroom is not necessarily increased. This is because the determinist viewpoint held by some technologists is flawed; the diffusion of technology in education is not autonomous. Education technology is a collection of instructional tools controlled by people (Surry, 1997). Change through technology is reliant on the teacher – the learning facilitator in the classroom - who not only determines the use of an innovation (Hall & Hord, 2015), but has the power to accept it or reject it (Blackwell, Laricella, Wartella, 2016; Ertmer & Ottenbreit-Leftwich, 2010; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012). This dissertation study explores teacher-led change when new technology is introduced by an external entity and considers ways to promote and identify outcomes that improve the learning experience in the classroom.

A Creativity Perspective

As postulated by Morrison, Ross, and Cheung (2019), change through technology occurs through a change in instructional methods as opposed to the introduction of technology alone. However, any change to instruction as a consequence of new technology must offer value to the learning experience as it relates to a specific context (Cukurova, & Luckin, 2018). Absent this improvement, the introduction of technology is meaningless. Although somewhat subjective, the value of technological changes in society can be easy to detect; for example, the advent of social media platforms revolutionized the advertising profession by providing brands with new opportunities to target consumers. Likewise, navigational apps on mobile phones led to a significant disruption within the taxi driving profession. These experiences – when they first arrived – were not only accepted as new ways to communicate and navigate but were also perceived as offering more value than what existed before. As a consequence, they were quickly adopted by individuals, and systematic changes in practice occurred throughout these occupations. The professionals who initiated these changes engaged in acts of creativity within their respected professions. Whether they were a result of deliberate actions of experimentation or changes that came about through chance, the outcomes remained the same – observed improvements in practice.

To promote improved learning experiences using new technology, this study focuses on the creativity of people in the teaching profession. Plucker, Beghetto, and Dow (2004) define creativity as new and useful outcomes relevant to a specific context. Therefore, when investigating the use of digital technology in education, this study focuses specifically on promoting new and useful outcomes within an individual environment. This approach complements the concept of professional learning in education (see Learning Forward, 2011), which places greater emphasis on teacher agency when it comes to solving problems and improving learning in the classroom (Darling-Hammond, Hyler, & Gardner, 2017). Rather than seeing change through technology as something facilitated by an outside force, we look toward the teacher as the learner who must respond to a change in circumstances introduced as a consequence of technology (Calvert, 2016). Therefore, in this study new technology is not presented as a catalyst for change (Cukurova & Luckin, 2018), instead this investigation looks at change as a creative process enacted and led by the individual practitioner in the classroom.

A focus on teacher creativity is less common within education research (Bramwell, Reilly, Lilly, Kronish, & Chennabathni, 2011), which typically investigates creativity in education from a student perspective (Katz-Buonincontro, Hass, &

Friedman, 2017; Lehtonen, Kaasinen, Karjalainen-Väkevä, & Toivanen, 2016; Plucker & Dow, 2010). General concepts of teacher creativity (i.e., new and useful outcomes), exist within the literature on teacher change, to which this dissertation will utilize, however, given the priority to cultivate creativity in students (Gray, 2016), this dissertation values the opportunity to teach and promote concepts of creativity in teachers. Furthermore, as highlighted by Shraub (2009), technology integration in schools is an ongoing process, likened to pushing a giant boulder up a hill, only to reach the top and see it roll back down again. Rather than viewing this experience as constant change within the teaching position, we posit teacher creativity as something more inviting to promote when responding to new technology, especially when focusing on individualized actions in the classroom.

A Sociocultural Perspective

As a constructivist philosophical approach to learning, sociocultural perspectives consider how an individual's existing knowledge and experiences contribute to the construction of new knowledge by establishing new schema for the learner (von Glaserfield, 2005). However, unlike other forms of constructivism, sociocultural perspectives focus almost exclusively on interactions in the environment. Relationships with people are particularly important, as learning is less about what an individual can accomplish on their own, and more about what they can accomplish with the support of others (Vygotsky, 1978). Learning is also situation-specific; knowledge construction is considered a new tool that an individual must learn how to use within a specific context. When outside that context, knowledge has little value (Brown, Collins, & Duguid, 1989; Resnick, 1987). Other tools and objects in the environment are presented as affordances, and their contribution to the situation is determined by how they are perceived and used by the learner (Vygotsky, 1978; Gee, 2008). A tool or object can be used as a mediating device that improves upon a situation in a way that cannot be accomplished without it, or alternatively, it can be determined as an object with little value or interest (Gee, 2008). As we will explore in the coming sections, we present new technology as a mediating device that offers expanded affordances within a teacher's environment. The actions a teacher takes in response to these affordances is what will influence the outcomes they produce within their practice.

Sociocultural View of Creativity

Emerging sociocultural views on creativity have gained momentum in recent years, as demonstrated through the development of a manifesto titled *Advancing Creativity and Research: A Sociocultural Manifesto* (Glaveanu et al., 2019). The manifesto shares twelve statements about creativity that acknowledge influences of culture, interactions with people, relationships with time, and the importance of exploring the value of creativity as it exists within a specified context. The manifesto does not challenge previous research that might have focused exclusively on individualized units such as personality traits or skillsets but emphasizes the need to acknowledge the complexity of the creativity phenomena. Consequently, when investigating teacher creativity, this study must consider the varying external influences that exist within a teacher's environment, and how these influences contribute toward the actions that a teacher takes when engaged in a change process using new technology.

Five-A Framework of Creativity

This study adopts the Five-A framework for creativity (Glaveanu, 2013), which builds on the early work of Mel Rhodes (1960). Rhodes separated creativity into four themes for study: person, process, product, and press (meaning environment). However, applying a sociocultural perspective to creativity, Glaveanu argued that these "units of analysis" should not be studied separately, as they collectively contribute to creativity in the environment (Glaveanu, 2010, p. 80). To address this concern, Glaveanu (2013) presented the Five-A framework as a way to challenge creativity researchers to consider the combined relationship of the actor, action, affordance, audience, and artifact, and how these units interact within a specific context. Glaveanu (2013), presents this framework as a way to investigate creativity in a variety of different domains, including an education environment. Consequently, Table 1.1 presents the Five-A framework from the perspective of teacher creativity, which is situated within a traditional school environment.

Five units of analysis. The actor considers the "importance of human interactions during creative activity" (Plucker & Alanzi, 2019, p. 502), which includes how an individual's existing knowledge of a situation influences how they perceive and interact with tools in their environment (Glaveanu, 2013). Action considers how the individual engages within their environment, including the internal and external process to which they interact with people, objects, and tools. Affordances align with the work of other sociocultural theorists who consider this term to represent objects and tools available within an individual's domain (Gee, 2008). This unit of analysis is of particular interest to education technology research, as it considers the use of a particular affordance such as a new application on an iPad, by how it is perceived, explored, and connected to existing affordances by the teacher (Glaveanu, 2013).

The next two components of the Five-A framework present the artifact and audience. The artifact represents the outcome and its relationship within a specific environment, and an audience considers the people within that environment and how they perceive the newness and usefulness of the artifact. However, an audience can also contribute to the creation of the artifact by providing forms of feedback along the way; consequently, the actor might make decisions based on how they interpret the expressed needs and preferences of their audience (Glaveanu, 2013). This unit within the five-A framework is another item to emphasize when investigating teacher change, as it considers how education leaders can influence the decisions a teacher makes in the classroom (Ertmer & Ottenbreit-Leftwich, 2010; Mei Kin, Abdull Kareem, Nordin, & Wai Bing, 2018; McLeod, Richardson, & Sauers, 2015). If a teacher perceives their idea as something that is potentially valued by the administration, they might be more inclined to pursue that idea. Likewise, if they feel their idea might be negatively received, they might become less willing to design and implement that idea any further.

Table 1.1

Five-A Framework for Teacher Creativity

	Five-A Framework	Teacher Creativity and Technology
Actor	The existing knowledge and experiences of the person contributes to how they perceive and manipulate new and existing affordances within their environment.	The knowledge and experience of the teacher contributes to how they perceive and manipulate new and existing technology within their classroom environment.

Actions	The internal and external actions that contribute to the process undertaken by the actor as they identify, explore, and manipulate affordances in their environment.	The actions a teacher takes as they respond to a change in circumstances introduced as a consequence of new technology.
Affordances	Considers objects and tools (including technology) that exist in the environment. An actor has the power to determine how these objects and tools interact with the environment.	Considers objects and tools in the classroom; this includes the physical space, furniture, existing technology and IT infrastructure, as well as affordances introduced with new technology.
Audience	The people who exist within the social context; their relationship with existing affordances; how they interact with the outcome, including during its development.	The people who exist within the school community, this includes students, parents, teachers, and members of a school's administrations team.
Artifact	The outcome produced, including its relationship to the environment and how it is perceived and used by the audience.	Outcomes produced by the teacher. Measured based on how they are measured and perceived by members of the school community.

Note: Glaveanu's Five-A framework (2013) adapted for a study on teacher creativity using new technology.

Change and Technology

In the field of education, what constitutes a change to the learning experience has received significant attention from practitioner-scholars and educational researchers (Hancock, Knezek, & Christensen, 2007; Maddux, Johnson, & Willis, 1997; Montrieux, Raes, & Schellens, 2017). Alison King's (1993) *Sage on Stage or Guide on the Side* article, provides one view to compare a traditional learning experience, versus that which can be considered new or different from the perspective of the learner. Alison King highlights that the one-way transfer of information by the teacher, who stands at the front of the classroom like a "Sage on the Stage" (p. 30), dominated the traditional school environment during the latter part of the twentieth century. In these learning experiences, the student's role is that of a passive consumer of information who is challenged to commit content to memory. The concept of the guide on the side challenges the traditional approach of the teacher and compliments the constructivist and social constructivist views of learning. These learning theories consider the act of learning as something that cannot be achieved adequately via the one-way transfer of information from the teacher to the student (von Glasersfeld, 2005) and instead places emphasis on supporting the construction of knowledge by the learner. Furthermore, existing research has investigated the relationship between constructivist approaches to learning and technology use in the classroom (Barak, 2017; Montrieux et al., 2017). Findings suggest that technology supports a student-centered approach (Zielinski, 2017), with educators who hold constructivist attitudes more likely to use technology in their practice (Overbay, Patterson, Vasu, & Grable, 2010).

Consequently, this view presents a valued change as a pedagogical change where students generate knowledge within a real-world context (Resnick, 1987) or construct meaning by actively producing information by participating in social interactions with other students (Gee, 2008; Vygotsky, 1978). This type of experience is student-centered because the teacher assumes the role of a guide on the side, where knowledge construction is led by the student through conversations, problem-solving, and producing outcomes that have value beyond the four walls of the classroom.

However, transitioning toward a new philosophical approach to learning is not the only change in practice that might produce a valued outcome. Guskey (2014) promotes teacher change as "modifications in teacher procedures or classroom format" that improve any aspect of learning (p. 383). From a teacher's perspective, this change might not necessarily see an immediate increase in student test scores, but it might improve the delivery of material, increase feedback, or elevate engagement. Although not necessarily constituting an immediate transformational change in practice (see Rohlwing & Spelman, 2014), these less evident changes might improve learning outcomes or increase classroom efficiency. For example, different methods for producing video tutorials can increase a student's understanding of the material (Fiorella, Kuhlmann, Stull, & Mayer, 2020), and variations in how information is visualized on a screen can impact retention of information (Mayer, 2017). Likewise, improved approaches to examples (Fyfe & Nathan, 2019) and increasing opportunities to provide students with feedback (Hattie, Gan, & Brooks, 2017), can all contribute to modest increases in student learning. Therefore, meaningful changes in practice constitute as outcomes that improve the learning experience for the student or the teacher. Consequently, change is not dependent on the use of technology, but rather the way these new affordances "recreate" and "reorganize" the classroom experience (Mills & Tincher, 2003, p 383). This view of change aligns to existing perspectives of creativity, which range from everyday acts of creativity to large scale creativity that occurs within an entire domain (Merrotsy, 2013)

Conceptual Framework

Research for technology in education has identified a collection of first and second-order barriers that influence technology use in school (Ertmer, 1999). First-orders barriers consider extrinsic factors such as professional development, the administration, and school culture (Blackwell et al., 2014; Ertmer & Ottenbreit-Leftwich, 2010), whereas second-order barriers refer to the internal motivations of the practitioner (Blackwell et al., 2016; Ertmer et al., 2012). These factors focus on teacher attitudes (Curwood, 2014), pedagogical beliefs (Overbay et al., 2010), self-efficacy concerns (Teo, 2009; Zimmerman & Kulikowich, 2016), and personal attributes of the teacher (Inan & Lowther, 2009).

Knowledge of first and second-order barriers provides an understanding of a teacher's environment, as well as what might influence their response to the introduction of new technology. As shown in Figure 1.1, this understanding contributes to a conceptual framework for teacher creativity and how this emerging construct is situated within a school community. Teacher creativity represents the actor (i.e., the teacher) and the actions they undertake when presented with new technology. It also includes the outcome a teacher produces as a consequence of those actions. However, adhering to the Five-A framework, this particular component also extends into the physical environment so that it remains accessible to the people in the school who constitute as the audience. The figure also includes external factors that exist outside the school community, such as technology companies. This inclusion acknowledges the constant technological change taking place in society (Philbeck & Davis, 2018), and how those changes influence decisions taken inside a school community (Graafland, 2018).

Figure 1.1: Conceptual Framework for Teacher Creativity

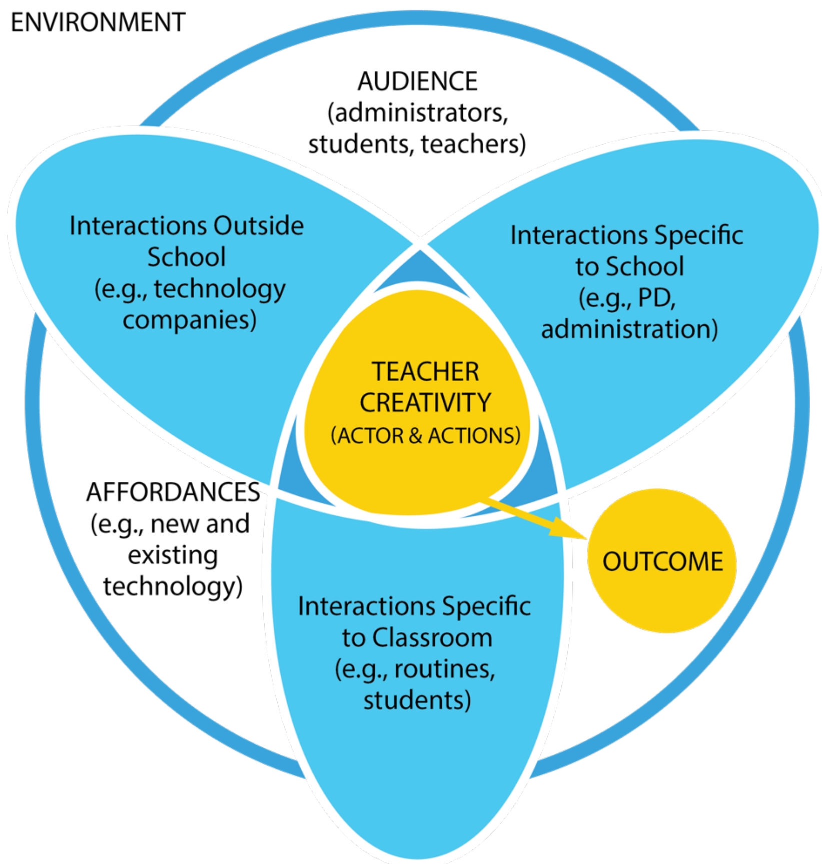

Figure 1.1: A conceptual framework of Glaveanu's Five-A framework, as situated within a teacher's professional practice.

Influences Outside School

The disruption caused by the technological changes that emerged during the latter part of the twentieth and early twenty-first century is routinely likened to the industrial revolution (Anderson, 2012; Philbeck & Davis, 2018). How history will compare the rise of the digital age with that of the first and second industrial revolutions is yet to be determined, but its immediate impact on how we produce and interact with information is already apparent within society (Gray, 2016; Gray, & Suri, 2019). Retrospectively looking at the disruptions caused by previous technological breakthroughs in society can provide us with a greater understanding of how people inside and outside school are responding today. Therefore, this section begins with a historical review of previous technological disruptions (e.g., the radio), before comparing these findings with what we currently understand about outside influences taking place today.

Industry Influences

During the early part of the twentieth century, the industrial revolution produced new thinking for the way industry was managed (Philbeck & Davis, 2018). Responding to a belief that schools should prepare students for future work, the emerging systems for manufacturing began to influence how schools were organized (Marzano, Frontier, & Livingston, 2011). Today, the connection to school and the workplace remains strong (Spring, 2010), and as a consequence, digital technology is deemed highly important in education thanks to its connection with the workforce (McLeod & Shareski, 2018; OECD, 2018; OECD, 2019; U. S. Department of Education, 2017). For example, a U.K. select committee report called *"Make or Break: The UK's Digital Future* (2015) emphasized the changes digital technology has brought to the workplace, and the need to develop an adequate "talent pipeline" in education (p. 46). Another report titled *Education: Digital technology's role in enabling skills development for a connected world* (Devaux, Belanger, Grand-Clement, & Manville, 2017), repeated the same call, and asked the question; Is education preparing today's young people for tomorrow's jobs using yesterday's tools? (p. 2). A similar report about a study conducted by the Brookings Institute called *Digitalization, and the American Workplace* (Muro, Liu, Whiton, & Kulkarni, 2017) called on schools to broaden the digital talent pipeline and increase access for unrepresented groups in education.

Technology Giants. Major technology companies like Apple, Facebook, Google, and IBM are influencing the use of technology and the curriculum. For example, each of these corporations either fund alternative schools or worked closely with local municipalities to produce specialized programs (see Williams, 2018). Furthermore, the emphasis placed on specific skills associated with industry has influenced technological movements such as those seen within personalized learning (Herold, 2017; Roberts-Mahoney, Means, & Garrison, 2016). It is not clear whether these technologies effectively improve education (Bulger, 2016; Pane, Steiner, Baird, Hamilton, & Pane, 2017), but interest in this approach continues nevertheless (Saltman, 2016).

The Rise of the Brand Ambassador. Support for the curriculum is not the only way large technology companies are influencing technology use in education. Companies like Apple, Google, and Microsoft have long established educational outreach programs to create so-called brand ambassadors within a school community (Singer, 2017b). For example, in 1985 Apple Inc. launched the Apple Classroom of Tomorrow initiative, a joint program with the National Science Foundation and three U.S. school districts. The objective was to study the way technology could be used as an agent for change (Apple Computers, 1995). This type of involvement in education has continued with the collaboration to create a Doctor of Education program with Lamar University and establish the Apple Educators program for teachers in 1994 (Apple Distinguished Educators). Similar education programs exist at Microsoft (Microsoft Certified Educator) and Google (Google Educator), as well as smaller education technology companies like Newsela (Newsela Certified Educators).

The programs targeted toward teachers are particularly relevant for this study, as they can influence the decision to formally introduce a technology within a school or district. Singer (2017a) attributes the rapid rise of Google's education suite to the experimental use of the platform by individual teachers in the classroom. Many schools and districts then formally adopted this technology to address concerns about privacy and ongoing requests from teachers. Subsequently, Google has increased its grassroots marketing campaign to target individual teachers (Singer, 2017a). More recently, Apple have expanded their education program by awarding schools a special status for use of their products (e.g., Apple Distinguished Schools).

The actions taken by today's technology giants are not that dissimilar to the actions taken by companies that proceeded them. One of the first electronic devices used in education was the radio (Bagley, 1932a). Similar to the perception of social media, proponents for the radio in education argued for its use based on outside popularity of the technology; thinking that it would be more successful in engaging students in the content (Bagley 1932a; 1932b). However, as schools began to incorporate the technology into the classroom, problems arose with the content available (i.e., radio shows), which was made by outside entities. Although, there were examples of consultation with teachers (Bryson 1943), the fixed times of broadcasts and the need to prepare the appropriate materials meant that the radio struggled to penetrate the four walls of the classroom (Cassidy 1998). Therefore, technology companies have a history of serving as outside influences on technology use in schools.

Societal Influences

The participatory nature of digital media has established a culture that has taken greater control over information shared, consumed, and produced within society (Jenkins, 2014). The use of social media outside the four walls of the classroom serve as an example to the ways people "co-create" information (Jenkins, 2014, p. 6), and form highly networked communities built on sharing, producing, and consuming content (Boyd, 2014). The popularity of social media channels like Facebook, Twitter, and Instagram, have encouraged some educators to integrate social media application into formal education environments to replicate this behavior inside the classroom (Prescott, Wilson, & Becket, 2013). This approach reaffirms a belief that technology can better engage students in the curriculum. However, choosing to integrate a technology based on its popularity outside, does not always produce the intended results (Ciampa, Thrasher, & Revels, 2016; McLeod & Shareski, 2017). Consequently, like the radio, the adoption of technology outside the classroom can influence technology decisions made inside the classroom, even if little evidence exists to support its impact on learning (Cavanagh, 2017).

Digital Divide

Although, equal access to digital technology is less of an issue for education (Dolan, 2016; Rafalow, 2014; Warschauer, Zheng, Niiya, Cotten, & Farkas, 2014), a divide remains in how technology is used between schools with different student concentrations of low and high social economic status (SES). For example, Warschauer, Zheng, Niiya, Cotten, and Farkas (2014) conducted a study on three similar one-to-one programs implemented at three schools, which differed in their concentrations of students from high and low SES backgrounds. Their study found that although the objectives and technology were similar, the program was successful at the two schools predominantly serving high and medium SES students, while reporting that the program was unsuccessful at the school with the most significant concentration of low SES students.

Rafalow (2014), conducted a similar comparative study to investigate how teachers differed in their use of the interactive whiteboard. As part of a qualitative research project, Rafalow found a similar disparity between technology use in schools that service high and low SES populations. The study found that the teacher serving a higher concentration of low SES students used the device like a traditional chalkboard 100% of the time. Whereas the teacher from the school with a more substantial concentration of high SES students expanded beyond the traditional experience 90% of the time.

These two examples suggest that although physical access to technology is less of a concern, varying concentrations of high and low SES students may influence the changes that occur. With teachers working in schools with higher concentrations of low SES students less likely to produce valued changes as presented in this study. These concerns are also expressed within *The U.S. Department of Education's Reimagining the Role of Technology: The 2017 National Education Technology Plan Update* (2017), which references a divide between students who are using devices creatively in their learning, and those using them as a supplement for the one-way transfer of information. This issue forms the basis of what Graafland (2018) refers to as a second and third-level digital divide, where acquired skill and use of the technology, raises greater concerns for educators than access to technology.

Childhood Development

Despite the popularity of technology outside formal schooling, there are concerns within society for how much time children spend interacting with digital technology and what impact this might have on childhood development (Collier et al., 2016; Kirkorian, 2018). For example, research has investigated the connection between video games and violent behavior (Gentile, Bender, & Anderson, 2017), and similar studies have investigated screen time and language development in young children (Penuel et al., 2010). The American Pediatrics Association (2018), incorporates this research in the recommendations they make for technology use in the home; stating the negative health impact technology can have on children and adolescents. These references include problems with sleep, attention, and learning, as well as the exposure to inappropriate or unsafe content such as pornography.

Other research has investigated the benefits of technology use in support of learning. For example, Penuel et al. (2012) investigated the use of media in preschool classrooms and found that children's literacy skills improved after being shown small clips from PBS shows. Other research has found mobile apps can help promote language development, even without an adult's presence to guide the child's instruction (Walter-Laager, Brandenberg, Tinguely, Schwarz, Pfiffner, & Moschner, 2017). These conflicting views of digital technology are likely to influence how people in society perceive the use of digital technology within education (Blackwell et al., 2014). Therefore, the response of the broader school community, which includes parents and policymakers may also influence decisions inside school, including how technology is received and used by teachers inside the classroom.

Influences in School

Prominent factors in a school community that influence technology use include educational leadership, professional development, and technology support (Baylor & Ritchie, 2002; Blackwell et al., 2014; Ertmer & Ottenbreit-Leftwich, 2010; Inan & Lowther, 2009). This section will consider the ways these external forces influence a teacher's environment and the circumstances of a change event introduced as a consequence of new technology. Educational leadership and professional development are two factors stressed within the literature when it comes to influencing a change in teacher practice (Cuban, Kirkpatrick, & Peck, 2001; Darling-Hammond et al., 2017; Ertmer et al., 2012; Hall & Hord, 2015; Robinson, Lloyd, & Rowe, 2008).

Educational Leadership

Educational leadership encompasses a broad spectrum of administrative responsibilities within a school and its surrounding district. Research in this field considers educational leadership in the development of new initiatives (Duran, Brunvand, Ellsworth, & Sendag, 2012); how attitudes in leadership impact the implementation of government policy (Webster, 2017); and how support from leadership influences the way an individual teacher responds when presented with a new challenge (Baylor & Ritchie, 2002; Kafyulilo, Fisser, & Voogt, 2016; Peled, Kali, & Yehudit, 2011). As technology integration involves technology procurement, technology training, and administrative support, educational leadership is a significant factor to consider when challenging teachers to use new technology.

Technology Procurement. Administration support is required for the development and implementation of new technology programs within a school, especially as they incur costs associated procurement and training. Although technology decisions that exclude teachers can negatively impact classroom use (Warschauer et al., 2014), Morrison, Ross, and Cheung (2019) show that teachers are not regularly engaged in technology purchasing decisions. Furthermore, education leadership doesn't seem to prioritize evidence-based research when it comes to technology procurement (Cavanagh, 2017; EdTech Efficacy Research Symposium, 2017; McLeod & Richardson, 2011), and this suggests a lack of consensus on what constitutes to an effective use of education technology in the classroom (Kirkwood & Price, 2014). Other known factors shown to influence technology decisions include cost (Ribeiro, 2016) and a general a fear of being "left behind" when compared to other schools in the district (Webster, 2017, p. 33).

These findings indicate technology decisions are not made in support of strategic goals, or in response to evidence on how they influence learning. Therefore, technology decisions lack vision from the administration (Machado & Chung, 2015), and suggest a determinist view of technology - meaning the mere purchase of a technological product is considered sufficient to bring about the intended change (Webster, 2017). With the perceived absence of leadership and a feeling of inadequate skills (Kuh, 2016), teachers are presented with ill-defined problems when challenged to use a new device or application. Ill-defined problems are characterized by a high level of ambiguity that results from a lack of information and direction toward the intended outcome (Horst, Rittel, & Melvin, 1973; Rowe 1991). While some professions might encourage training on how best to approach ill-defined problems, the concept of ill-defined challenges is less common for teachers who focus on best pedagogical practices and learning subject matter relevant to the teacher. Consequently, the constant evolution of digital technology may challenge teachers to think in new and different ways that were not applicable before the Digital Age.

Professional Development

Designing professional development programs is viewed as one way to facilitate teacher change in the classroom (Reutzel & Clark, 2014). However, research suggests that despite significant investment, professional development does not always deliver sustained change or an improvement in student learning outcomes (Avalos, 2011; Reutzel & Clark, 2014). Furthermore, there is a disconnect between teachers and those who are responsible for organizing and facilitating professional development in schools (Darling-Hammond et al., 2017). A significant study conducted by The New Teacher's Project (2015), found that billions of dollars were invested annually on professional development projects each year with little impact in the classroom. The findings of this study suggest that an average teacher spends approximately 19 days each year on formal professional development but only half will consider these activities as having any impact on their practice. This particular study has proved controversial in the education community, with some researchers counteracting the findings and stating that professional development – when implemented well – does lead to positive outcomes (Lemov, 2015a; Lemov, 2015b; Hill, 2015). However, despite the opposing views, there remains a general consensus that facilitating teacher change through formal professional development programs is a challenge that requires evidence-based planning (Darling-Hammond et al., 2017), differentiation for varying skills (Fenton, 2017), and an effort to connect the technology to the belief values held by teachers (Vongkulluksn, Xie, & Bowman, 2018).

Unfortunately for professional development involving new technology, evidence on how best to use these products is lacking (Cukurova & Luckin, 2018; Kirkwood & Price, 2014), with some suggesting schools should lead the discovery of effective uses of technology (Molnar, 2017). This situation makes it even more challenging to plan effective professional development for new technology, which is concerning as professional development is considered an important factor in the successful use of technology in the classroom (Albion, 2001; Blackwell et al, 2014; Sevillano-García & Vázquez-Cano, 2015). Information workshops offer an opportunity to communicate information about new technology, which from an innovation diffusion theory perspective, can help can reduce the uncertainty of the technology during the initial stages of the integration process (Rogers, 2003). Unfortunately, technology training can assume a short passive approach (Curwood, 2014), which contradicts research that suggests greater time is needed for teachers to explore new technology (Fenton, 2017; Patahuddin, 2013). Furthermore, absent vision from the administration, rushed professional development experiences might lack explicit examples, which is a factor known to impeded adequate knowledge construction in learners (Fyfe & Nathan, 2019; Renkl, 2017). This might be one reason teachers report having gaps in their knowledge after receiving training on new technology (Duran et al., 2012).

Finally, short passive approaches to professional development do not accommodate a preference for collaborative learning (Kuh, 2016) or address concerns toward how technology will disrupt individual practice (Yoo & Carter, 2017). Knowing that intrinsic factors of the teacher influence how they interpret a change event (Anderson, 2017), greater care is needed when it comes to professional development using new technology, especially when there is an intent to produce a creative outcome. Within social cognitive theory, these two factors can combine to influence how teachers learn technology, by shaping the information presented in a way that is consistent with a teacher's existing mental framework (Bandura, 1986; Bruning, Schraw, & Norby, 2011). Consequently, how a teacher makes sense of a change in circumstances isn't always consistent with how it is perceived by others (Spillane, Reiser, & Reimer, 2002). Although a teacher might consider the mere use of an interactive whiteboard as contributing to a valued change in practice, others might consider it similar to the one-way transfer of information via a chalkboard, and therefore not consider it a change when compared to what existed before. These varying perspectives make technology training, and evaluating its success challenging.

Influences in the Classroom

Extrinsic factors in a teacher's classroom are particularly important, as this micro-environment represents the teacher's individual practice, and therefore likely location for teacher creativity. Focusing on the teacher's classroom highlights that factors common in the wider school community may manifest differently within this specific context. For example, examining a school's IT infrastructure is only relevant based on what aspects of that infrastructure exist in the classroom. Likewise, the number of devices per student, students' knowledge of technology, and their attitudes to technology, are all factors that can vary from classroom to classroom. Consequently, this section considers relevant factors that may vary by classroom.

Classroom Routine

Classroom routines are considered an essential strategy for classroom management (Emmer & Stough, 2010). Past research has shown that established routines can predict academic achievement (Evertson & Emmer, 1982), and are known to help minimize classroom disruption (Lester, Allanson, & Notar, 2017). Furthermore, a teacher's routine within the classroom can reduce ambiguity by providing greater control and predictability for the learning experience (Fink & Siedentop, 1989). However, sustained routines can quickly form habits that initiate routine behaviors (Wood & Rünger, 2016). These habits can then support or hinder the learning experience (Fiorella, 2020). For example, a teacher might reduce cognitive overload with established habits, leading to increased opportunities for reflection and observation (Jamil & Hamre, 2018). Rather than focusing on implementing something new, a teacher with an established routine is simply implementing what they already know. They can therefore reflect on their practice more efficiently, while also focusing on the needs of a student.

Consequently, when introducing new technology for the classroom, a teacher may consider the relationship that technology has with existing habits in the classroom. For example, Patahuddin (2013) conducted a qualitative study to investigate how information obtained from the world wide web might support a teacher's professional development using an interactive whiteboard. Her study found that although the teacher was able to locate a variety of online resources that could enhance the use of the technology, they remained reluctant to incorporate these tools until they connected them with established routines.

Another qualitative study conducted by Chen (2008), found established routines in the classroom can conflict with expressed beliefs toward a technology. As a consequence, a teacher might express positive attitudes toward the integration of a new application or platform; however, the actual implementation may become hampered if the teacher is unable to incorporate the technology into their existing routines. Therefore, the impact of classroom routines represents a factor that teachers must address when responding to the introduction of new technology in the classroom. Habits that exist within the environment are part of a teacher's established domain. If a new technology is perceived as challenging those habits, they might impact a teacher's willingness to incorporate that technology even if they express positive attitudes during its introduction. Furthermore, challenging established habits may explain why technology integration is sometimes perceived as an "add-on" to a teacher's existing practice (Cassidy, 1998, p. 182), as it requires a change that extends beyond using the technology.

Student Attitudes

Although attitudes to technology in education often focus on the teacher, students' attitudes might also influence how a teacher uses technology. This is because students exist as a direct audience within a teacher's environment. The teacher is producing outcomes for them, and consequently will work to produce outcomes for their benefit. As discussed previously, technology is often perceived as a tool that supports student-centered learning and is regularly promoted as a way to support a constructivist approach in education. However, in a study conducted by Montrieux, Raes, and Schellens (2017), students exhibited a preference for a traditional approach to learning, as opposed to an alternative constructivist activity. In the study, students were set up with three different activities using an iPad. The first was an independent activity that required students to use the iPad to construct meaning separate from the instructor. A similar exercise was then set up with the iPad; only this alternative experience included greater involvement from the teacher, who assumed a somewhat more traditional role in the transfer of information. The final activity did not include the iPad. Students in the class overwhelming preferred the activities that utilized the iPads, however, they felt that the constructivist approach required additional work that required more time to learn the content. In this incident, it was the students who expressed a resistance in the change of approach to the learning experience.

Assumptions about student preferences can also drive the introduction of new technology in education (Kirkwood & Price, 2013). The inclusion of social media for example, is pursued on the assumption that these platforms are popular outside education, and therefore will prove popular inside. However, in a study conducted by Ciampa, Thrasher, and Revels (2016) students demonstrated a preference for existing methods of communication (i.e., email and an existing learning management systems), as opposed to the introduction of new methods using social media (e.g., Facebook). However, other studies have found that students favor the use of social media when enacted as a tool that facilitates a learning community (Hung & Yuen, 2010; Prescott et al., 2013). Although this research does not indicate a preferred change of practice in either direction, it demonstrates that a teacher's audience in the classroom (i.e., the students) may have an attitude toward new technology that changes under different conditions.

Influences of the Teacher

The decision to introduce a new technology into an education environment challenges an individual teacher to - willingly or unwillingly - integrate that technology in their practice. New technology is an innovation, because it introduces something new to an individual or community (Rogers, 2003). Applying Rogers' (2003) innovation diffusion theory to this section, we know that any innovation introduces a "newness" factor that will produce ambiguity for the teacher (p. 6). This is because a decision to adopt the innovation, will require some type of change to an existing practice. For some this change might require only minor adjustments, but for others the change might be significant. Whatever the magnitude, change is something conducted by the individual practitioner (Hall & Hord, 2015).

Although first-order barriers - as explored above - impact a teacher's capacity to make changes to their practice, we still look to these individuals to grow "despite the system" (Fullan, 1998, p. 221). Therefore, having a "willingness to learn" is a necessity if teachers are to engage in a learning process with new technology (Eekelen, Vermunt, & Boshuizen, 2006, p. 409). However, as shown in a study by Eekelen, Vermunt, and Boshuizen, (2006), multiple factors can influence a teacher's willingness to learn. These include a collection of second-order barriers such as teacher self-efficacy, pedagogical beliefs, and personal attributes, which are all known to influence technology use in the classroom. This final section will focus on these second-order barriers from the perspective of what intrinsic factors are particularly influential when challenged to produce a creative outcome using new technology.

Teacher Attitudes

Teacher attitudes are one of the most significant barriers to technology use in the classroom (Inan & Lowther, 2009). Pedagogical beliefs are particularly influential for determining whether technology is deployed in support of traditional instructional methods or those perceived as student-centered (de Silva, Chigona, & Adendorff , 2016;

Montrieux et al., 2017; Overbay et al., 2010). Brawner and Allen (2006) explored pedagogical beliefs among preservice teachers and found this attitude influential in predicting future decisions of technology use. Furthermore, research shows that teachers who have a pedagogical attitude that aligns with student-centered instruction are more likely to integrate technology into their practice when compared to those who have an approach most closely aligned to traditional instruction (Kim, Kim, Lee, Spector, & DeMeester, 2013; Overbay et al., 2010).

How teachers perceive themselves with technology (Curwood, 2014) and their comfort with digital devices (Kuh, 2016), have also been shown to influence their attitudes toward technology. Teachers want to feel their knowledge and contributions are valued, and feelings of frustration, disempowerment, and vulnerability can manifest in situations where they cannot express their passions within the context of learning (Yoo & Carter, 2017). Furthermore, a teacher who perceives themselves as not being good with technology (Teo, 2009), or perceives themselves as lacking sufficient skills could worry that technology is a threat to their identity and existing belief about teaching and learning (Curwood, 2014).

Self-Efficacy

Bandura (1978) presented self-efficacy as an individual's belief in their capacity to replicate an observed outcome. When applying this concept in education, we consider teachers' belief in their ability to bring about a change that produce an improvement to the learning experience (Tschannen-Moran & Woolfolk Hoy, 2001). This concept serves as a second-order barrier in education and known to influence technology use (Lee & Tsai, 2010), as well as teacher change in the classroom (Yoo, 2016). For example, self-efficacy influences how teachers respond to stress when presented with curriculum changes (Putwain & von der Embse, 2019). It also is thought to have a relationship with how teachers perceive risk versus opportunity (Krueger & Dickson, 1994). Furthermore, self-efficacy is considered a factor in creativity (Bandura, 1986), which led Tierney and Farmer (2002) to propose a sub-construct called creative self-efficacy. The latter was used in a study by Jaussi, Randel, and Dionne (2007), and was considered a contributing factor to creative decisions made in the workplace.

Personality Traits

Research into the change process has considered how personality traits influence an individual's decision to accept or reject an innovation (Hall & Hord, 2015, Rogers, 2003), with some research focused on the adoption of new technology (McElroy, Hendrickson, Townsend, & DeMarie, 2007; Yang, Lu, Gupta, Cao, & Zhang, 2012). Specific personality traits like openness to experience are considered influential when it comes to individual creativity (Dollinger, Urban & James, 2004; McCrae, 1987; Kaufman et al., 2016), and therefore might impact teacher creativity in the classroom. For example, George and Zhou (2001) found that teachers who scored high for openness were more likely to produce creative outcomes using new technology, especially when subjected to experiences that were ambiguous.

As a construct, openness is defined as the extent to which an individual is open to change within an organization (Axtell et al., 2002; Miller, Johnson, & Grau, 1994), or open to new experiences (Goldberg, 1990; McCrea, 1987). This perspective includes factors such as the ability to resist premature closure when presented with a new challenge (Torrance & Safter, 1999), and the extent to which a person can tolerate ambiguity (Goldberg; 1990; McCrea, 1985; 1987). Furthermore, within change research, openness has been explored as an essential condition for planned change within an organization (Axtell et al., 2002), and considered as a dependent variable connected to the anxiety one experiences when presented with a new event (Miller et al., 1994). In education, openness is perceived as something influenced by an individual's self-efficacy, as well as their pedagogical discontent (Southerland, Sowell, Blanchard, & Granger, 2010), and has been found to be a factor that impacts not only the use of technology, but also its effectiveness in the classroom (Baylor & Richie, 2002; Blau & Peled, 2012). Although an investigation into personality traits and teacher creativity are beyond the scope of this study, the concept that personality is an influential factor on creativity and technology use continues to emphasis the importance of the individual when it comes to producing changes in practice using new technology.

Discussion

This first chapter presented a sociocultural perspective of teacher creativity as a way to increase meaningful change using new technology. Change under these conditions was presented as an outcome that improved the learning experience for either the student or the teacher. Within the review of literature, prominent first and second-order barriers were explored to determine those most influential when teachers are challenged to integrate new technology. This specific aspect of research focused on factors such as professional development, education leadership, teacher attitudes and teacher self-efficacy.

Rogers (2003) innovation diffusion theory presents three types of innovation decisions; the first is an optional innovation decision, which represent decisions made by an individual independent from the system. The second is a collective innovation-decision, which are those made based on consensus with other people in an organization. The final innovation decision is called an authority innovation-decision. The first two innovation-decisions are conducted by individuals or in collaboration within a department or school community. These types of innovation decisions are not mandatory and may arise after a teacher attends a conference or interacts within an external community. Whereas an authority innovation-decision are those most apparent within the context of this study. This type of innovation decision is typically conducted by the administration, as seen through the purchasing of a particular technology product absent consultation with teachers. As revealed in the research, many of these decisions are made absent evidence, and introduced into the community without vision or adequate training. This situation is perhaps one reason why the diffusion of technology in education is not enough to produce meaningful changes in practice.

As teachers are the most influential factor in the successful use of education technology in education, we must consider how to support them as they respond to new technology introduced by an authority innovation-decision. As presented in this study, teacher creativity considers the actions taken by the teacher, and the outcomes produced as a consequence of those actions. Concerns toward the impact on existing practices, including alignment to pedological beliefs are significant factors that can influence how teachers perceive new affordances. Likewise, personality traits can influence how individuals respond to the ambiguity introduced from a change event, and teacher self-efficacy is known to influence this process as well.

The lack of training and vision for technology use makes it clear that teachers require support through the change process. A focus on teacher creativity can help individuals place greater emphasis on valued outcomes that challenge traditional attitudes toward pedagogy and technology use. Furthermore, under the current circumstances of authority innovation decisions, there is a need to address the ambiguity that arises during the introduction of new technology and better understand this situation from the perspective of the teacher. With increased knowledge, we may have the capacity to develop an intervention that promotes creative outcomes using new technology and increases teacher agency for how they implement and evaluate change within the context of their classroom environment. This will address the haphazard way new technology is introduced in education, while working to promote teacher creativity as a way to address the constant disruption caused by new technology.

Chapter 2: Investigating Change Using G-Suite

In chapter one, we presented the introduction of new technology as an opportunity for teacher change in the classroom. We explored this topic from a creativity perspective, highlighting that a shift in practice that improves upon an existing situation constitutes as a creative outcome. We investigated factors that influence this process using Glaveanu's Five-A framework for creativity (2013) and identified those considered relevant from education research on first and second-order barriers (Ertmer, 1999). First-order barriers considered factors that exist inside the school, such as educational leadership, professional development, and classroom routines, but also influential factors that exist outside school. These included technology companies and cultural perspectives toward technology. Second-order barriers included pedagogical beliefs, a teacher's sense of self-efficacy, and personality traits.

Although first-order barriers influence how teachers respond and use technology, this study focuses on the teacher – more precisely, the actions they take in response to new technology and the outcomes they produce as a consequence of those actions. As discussed at the end of chapter one, there are different innovation decisions regarding this topic. This study is concerned about authority innovation-decision (see Rogers, 2003), which are the top-down decisions that might require teachers to participate in a 1:1 laptop program, adopt a change in learning management systems, or use a specific software in support of a schoolwide shift toward personalized learning. The teacher is the focus, as they assume the role of the actor within Glaveanu's Five-A framework, and consequently have the responsibility to creatively navigate this challenge if circumstances allow. This chapter presents information about the research site used to investigate teacher creativity using new technology and provides the results of an initial needs assessment conducted in Spring 2019.

Measuring Teacher Creativity

The actor is the teacher challenged to respond to the disruption caused during the introduction of new technology. Within this context, the teacher is tasked with having to respond to a "disturbance" in their practice (Havelock, 1973, p. 6). This situation involves first having to acknowledge the disturbance, and then choosing to pursue the necessary steps to explore it further (Havelock, 1973); only then can they generate ideas and implement a solution. This situation requires teachers to engage in the process of a change either willingly or unwillingly if they are to produce an outcome in response to this event.

Many factors can contribute to how a teacher experiences and responds to this challenge throughout the change process. For example, in chapter one, we spoke of a teacher's classroom as a place where routines offer a sense of control and predictability (Fink & Siedentop, 1989), with evidence suggesting that these routine can present a barrier to change when new technology is introduced (Drijvers, Doorman, Boon, & Reed, 2010). Therefore, the introduction of technology absent adequate vision or training might create an ambiguous situation for the teacher, which requires them to make changes to existing routines that provide a sense of control in the classroom. While some teachers might have the capacity to navigate their way through this problem to produce a creative outcome, those with a disposition for "risk-aversion" (Oreg, 2003, p. 680) or a lower tolerance for ambiguity might express resistance to the new technology (Dori, Tal, & Peled, 2002). When considering technology introduced under these circumstances, it is understandable why some teachers in this situation choose to respond by considering how best to integrate it into their existing practice (Ertmer & Ottenbreit-Leftwich, 2010; Patahuddin, 2013), as opposed to embracing it as an opportunity to be creative. Fullan (2001) explores this concept within change theory, stating that teachers aren't necessarily resisting change "as much as they don't know how to cope with it" (iv).

Hall (2010) likens the situation to crossing a bridge over a vast chasm (see Figure 2.1). On one side is the teacher's existing practice, while on the other side is a change to that practice. Hall explains how it takes time for the teacher to cross over the bridge and reminds us that not all teachers travel at the same time. The chasm represents the ambiguous nature of change (Fullan, 2001), and the destination is a known or unknown outcome considered new and useful for the environment. Therefore, the concept of crossing a precarious bridge offers a suitable analogy for teacher creativity using technology. The journey represents the actions a teacher takes as they interact with affordances and people in their environment. The destination is a new outcome that delivers a meaningful change in practice as measured within the context of the classroom or school community.

Figure 2.1: Making a Journey Toward Change

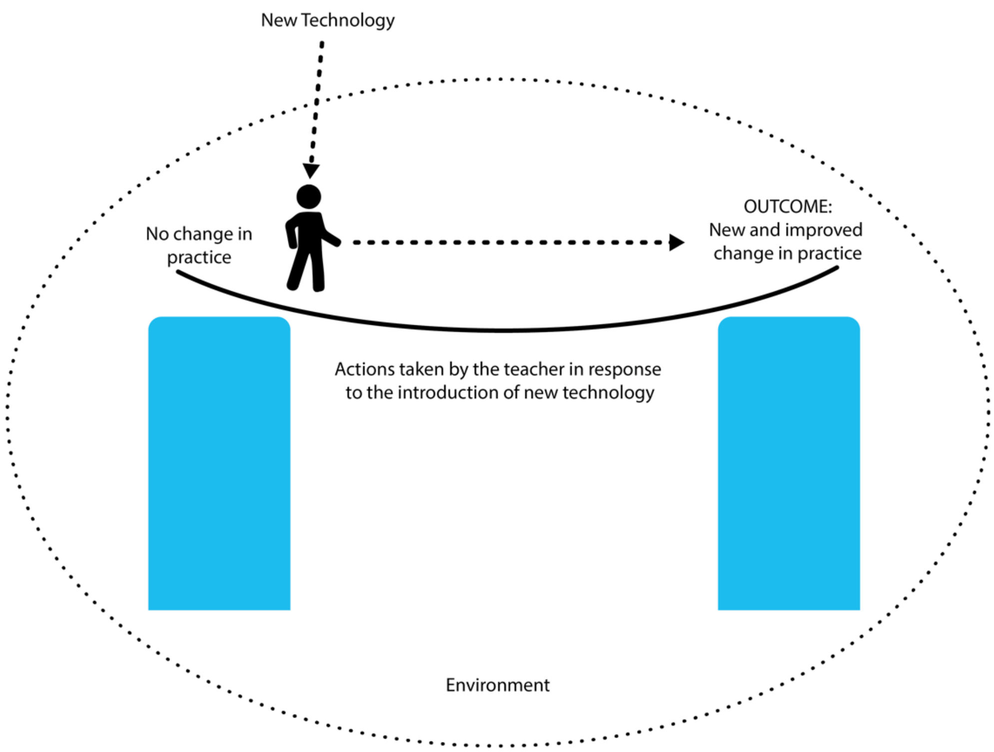

Figure 2.1: Modification to Hall's innovation bridge (Hall, 2010; Hall & Hord, 2015). The bridge represents a teacher's journey toward improved changes in practice using new technology.

Concerns-Based Adoption Model

The Concerns-Based Adoption Model (CBAM) provides a complementary framework for this study, as it acknowledges the use of technology will vary depending on the individual (Hall, 2010). CBAM is also particularly useful when investigating the introduction of new technology introduced by the administration (Straub, 2009), and provides a way to monitor a teacher's progress toward change. The theoretical framework of CBAM originates from the pioneering work of Francis Fuller (Hall & Hord, 1987), who was a professor at the University of Texas. Curious about the motivations she observed from preservice teachers in a graduate program, Fuller (1969) conducted a study to understand why they found it difficult to learn specific content. She proposed that these difficulties were a result of students not thinking the material was relevant to them. Subsequently, Fuller investigated ways to monitor this situation by identifying specific questions that represent changes in concerns about the learning experience. The outcome of Fuller's research led to the identification of three phases of teacher development. The CBAM framework built upon Fuller's research to produce seven stages of concerns that monitor different steps in the change process (Hall & Hord, 1987). Furthermore, as teacher concerns represent personal circumstances, experiences, and beliefs (Hall & Hord, 2015), the CBAM framework addresses some of the second-order barriers identified in chapter one.

As shown in Table 2.1, the early stages of the CBAM framework capture concerns relevant to existing practices. The middle stage represents concerns associated with experimentation and management, while the latter stages begin to signify a change is underway. Without an indication of a change in practice, we will not see a different outcome produced as a consequence of the technology (Hall & Hord, 2015). Therefore, as shown in Figure 2.2, CBAM helps measure teacher creativity, as it can indicate if a change is underway. Without an indication of change, it is unlikely that a teacher has completed the journey toward a creative outcome within the context of their professional environment.

Figure 2.2: Indications of Teacher Creativity

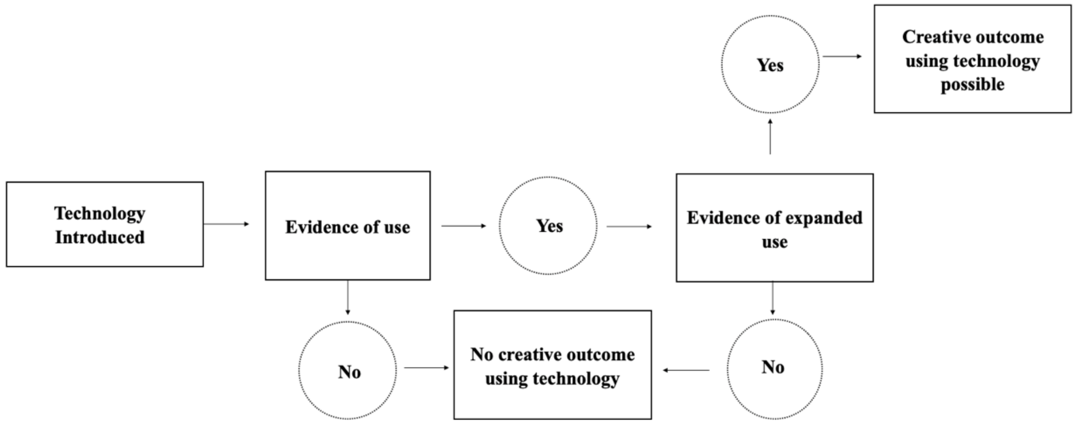

Figure 2.2: CBAM provides a way to investigate if a change is underway using the new technology. Without indications of change, it is unlikely a creative outcome has occurred.

Methods

Population

An email request was sent to an urban middle school in Connecticut, asking for permission to use it as a research site to study teacher creativity using new technology. After receiving formal consent, initial data collection began with reviewing school documents to understand the context of the G-Suite and other technology available in the school. The information included technology documents on the BYOD policy, a review of the school's website, and a semi-structured interview conducted with the principal.

The research site is an academy school with specialized themes in STEM and world culture. Furthermore, student enrollment comes from five surrounding districts, though data from the school suggests that the majority of students come from three towns. At the time of conducting the needs assessment, there were 599 students and 42 certified teachers across grades six through eight. Student demographics consisted of 48% white, 33% Hispanic, 8% Asian, and 7% black. Multiracial and American Indian represented the final 4% of the population. The student to faculty ratio was 15:1, and all students had access to a laptop as a result of full implementation for the BYOD policy. Approximately one-third of the school was on free or reduced lunch, and 4.5% were English language learners. Other technology products outside the G-Suite included Mobi Max, PowerSchool, Frontline Moodle, and subscriptions to Read180, Math180, and Quizlet. Furthermore, every classroom in the school had an Apple TV, projector, and all teachers had a Mac and an iPad.

Data collection consisted of a single survey distributed to 38 teachers attending a spring faculty meeting. Participation in the study was 95%, with 22 female, and 14 male respondents in total. Out of the 36 teachers who completed the survey, 17 had been at the school since its founding; seven had been at the school for three years; eight for two years, and three were finishing their first year. Data analysis represented 35 teachers at the school, as a consequence of respondent error by one female participant.

Instrumentation

A single survey containing three items was designed to investigate the two research questions (see Appendix A). The first consisted of three questions to gather demographic information (e.g., gender) and the number of years of teaching. The second scale used the CBAM Stages of Concern Questionnaire (SoC), consisting of 35 questions that measure teacher concerns across the seven stages of the CBAM framework. Retest reliability for this instrument is .65 to .86, and alpha coefficients fall within .66 to .83 (Hall & Hord, 2015). The tool remained unchanged, though the word G-Suite replaced the word innovation. Substituting this word with the name of the technology is recommended when using the instrument, which includes specifying information about the technology in the survey's instructions (Hall & Hord, 2015).

The final scale included three closing questions designed to capture information that might suggest a need to prioritize environmental factors, as opposed to the current emphasis on the individual. Suggested questions by George, Hall, and Stiegelbauer (2013), guided this final section. The first of these three questions gathered data on the number of years a respondent had used the G-suite platform in education. Anticipated time for adoption is approximately 3-5 years (Hall & Hord, 2015; Rogers, 2003). Consequently, a teacher who has used the platform for three years or more should have their highest level of concerns in the latter stages of the CBAM framework.

The second and third questions within this final item looked at whether teachers considered themselves a non-user, novice, intermediate, old-hand, or past users, and reported access to training of the G-suite. The latter question is relevant from the perspective of investigating the impact professional development has on the use of new technology. As found in the literature review, professional development is an essential first-order barrier to consider when exploring technology use, and consequently, an environmental factor that might influence the production of creative outcomes within the school. Although the principal stated that no formal professional development had taken place in support of the G-suite, teachers at the school do have access to professional learning opportunities offered by the district, education conferences, as well as online training resources.

Table 2.1

CBAM Stages of Concern

Cluster	Stage	Description of Stages

Impact	Refocusing	The focus is on the exploration of more universal benefits from the innovation, including the possibility of major changes or replacement with a more powerful alternative. The individual has definite ideas about alternatives to the proposed or existing form of the innovation.
	Collaboration	The focus is on coordination and cooperation with others regarding the use of the innovation.
	Consequence	Attention focuses on the impact of the innovation on students in her/his immediate sphere of influence. The focus is on the relevance of the innovation for students, evaluation of student outcomes, including performance and competencies, and changes needed to increase student outcomes.
Task	Management	Attention is focused on the processes and tasks of using the innovation and the best use of information and resources. Issues related to efficiency, organizing, managing, scheduling, and time demands are utmost.
Self	Personal	Individual is uncertain about the demands of the innovation, her/ his inadequacy to meet those demands, and her/his role with the innovation. This includes an analysis of her/his role in relation to the reward structure of the organization, decision making, and consideration of potential conflicts with existing structures or personal commitment. Financial or status implications of the program for self and colleagues may also be reflected.
	Informational	A general awareness of the innovation and interest in learning more detail about it is indicated. The person seems to be unworried about herself/himself in relation to the innovation. She/he is interested in substantive aspects of the innovation in a selfless manner such as general characteristics, effects, and requirements for use.
Unrelated	Unrelated	Little concern about or involvement with the innovation is indicated

Note: Descriptions taken from Hall and Hord (2015) and ordered by CBAM clusters and stages.

Data Analysis

The 35 statements contained on the SoC survey captured total scores for each stage of the CBAM framework. A respondent is asked to indicate their level of concern for each statement using a scale from zero to seven. Those who select seven are reporting a high concern toward that statement. For example, "I am preoccupied with things other than this G-suite" is a statement that measures teacher concerns in the unrelated stage of the CBAM framework (see Table 2.1). Teachers who have concerns they consider more important than adopting the G-suite will most likely reside within this group. Informational and personal are the next two stages in the CBAM framework. These stages capture teachers who want more information about the technology so they can better understand how it may impact existing practices. The management stage represents those who are now beginning to use the technology, and consequently, most likely express concerns related to implementation (e.g., time, organization, etc.). Finally, the last three stages are called consequence, collaboration, and refocusing; this cluster of the CBAM framework signifies increasing use of the G-suite and likely progression over the bridge. In total, there are five statements within the SoC instrument to represent each stage within the framework.

A total score for each participant was calculated for each stage of the CBAM framework. These raw scores were then turned into percentiles using a scoring rubric available from George et al. (2013) and investigated to identify peak concerns for individual participants. This process produced a new categorical variable that represented peak concerns toward the G-suite (see Figure 2.3). As individuals can have peaks in multiple stages (George, Hall, & Stiegelbauer, 2013; Hall & Hord, 2015), the total number of individuals contained in the graph is higher than those who completed the survey. The additional concern among the group is because one respondent peaked in more than one stage of the CBAM framework. Consequently, there were 36 concerns expressed toward the G-suite within this particular population of teachers. Average scores across the seven stages were also calculated to produce a group profile.

Results

Teacher Concerns

In response to the first question, Figure 2.3 shows that the unrelated stage contained the highest number of peaks, with more than three times the number of teachers in that stage than any other stage in the CBAM framework (n=21). The informational and collaboration stages had the second-highest number of peaks (n=5), followed by the personal and management stages (n=2). No teachers had peaked in the refocusing stage of the CBAM framework. Although less pronounced, the group profile exhibited in Figure 2.4 provides a similar result. However, visual elevation of the personal and management stages placed these two stages at the same level as the informational and collaboration stage.

Figure 2.3: Peak Concerns by Individual

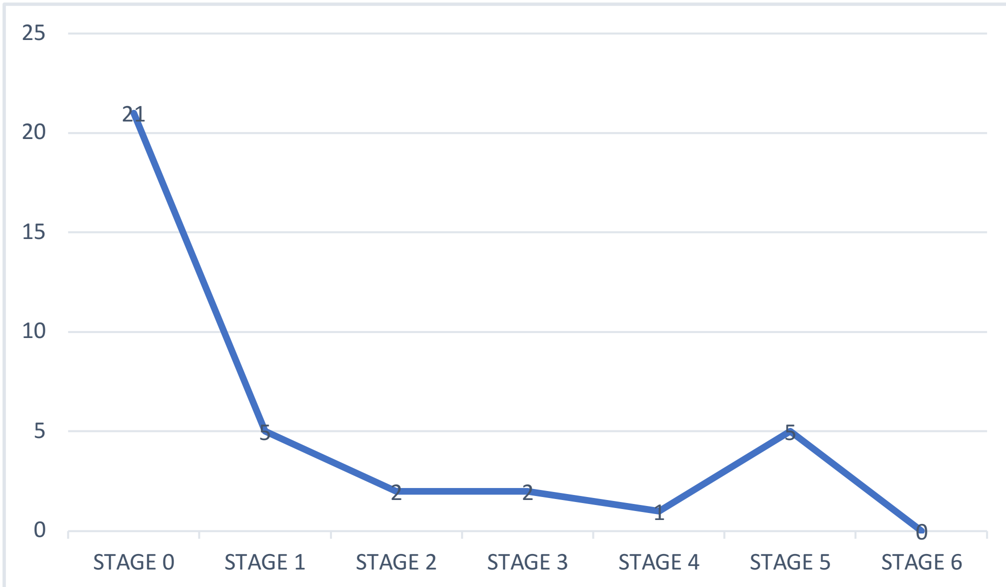

Figure 2.3: Shows a line graph to represent peaks in concern toward the G-suite platform four years after it was introduced at the school.

Figure 2.3: Average Scores for Group

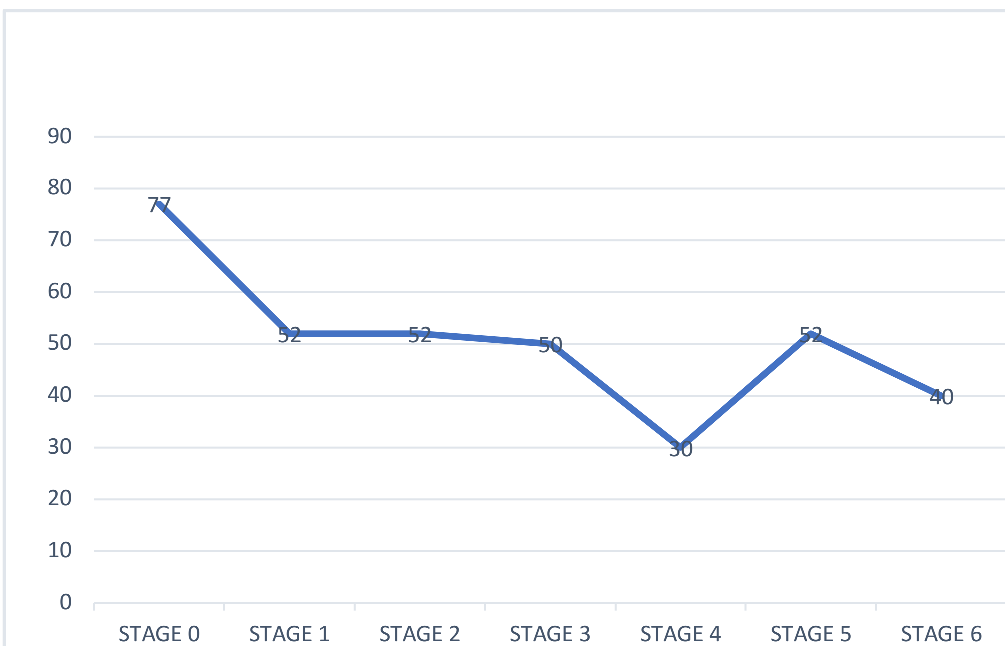

Figure 2.4: Shows a line graph to represent the combined average scores for each stage by group.

These findings suggest that the majority of teachers at the school were less involved or less concerned about using the G-suite at the time of the needs assessment. However, general scores in stages one, two, and five were elevated, and therefore suggest use or an interest in using the platform. Furthermore, five teachers who recorded peaks in stage five are expressing concerns associated with a desire to work closely with colleagues (Hall & Hord, 2015). Nevertheless, the overall results of the needs assessment indicate most teachers at the school are at the beginning of their journey using the G-suite. These results are surprising given the length of time the platform has existed at the school. Consequently, it is essential to consider different alternatives to explain these results.

The first alternative explanation is the possibility that many teachers have used the platform for so long that it is now part of their everyday practice. However, although this view might accommodate statements like "I am not concerned about the G-Suite at this time" it is less likely to help a statement such as, "currently, other priorities prevent me from focusing my attention on this innovation. Likewise, stage one captures concerns that express interest in wanting to know more about the platform. If high scores in the unrelated stage contained teachers who were no longer concerned about the G-suite, stage one concerns would likely be below what is presented within the data.

Another alternative and perhaps more likely explanation is associated with the number of applications contained within the G-suite platform. As the technology contains eight different apps that support teachers and students creating and sharing information in the classroom. Teachers may be familiar with some but not all of the G-suite tools available. Therefore, the results of the needs assessment could represent the applications teachers are less familiar about. This would accommodate the likelihood that popular apps like Google docs are used at the school, but other tools such as Google forms, or Google sites are less used.

Whatever the reason for the results, the data gathered showed an opportunity to explore teacher creativity using the platform four years after its introduction as a consequence of an authority innovation-decision. Whether teachers are not using the G-suite or are not using specific apps in the G-suite, there is a need to encourage greater use and expansion of this technology.

Comparing Stages of Concern

To address the second question, nominal variables that contained an ordinal relationship were transformed into numeric values in preparation for using descriptive statistics with SPSS version 26. As shown in Table 2.2, data analysis revealed that most teachers had either been at the school since its opening or started a year later. Although the majority of teachers had been at the school since its opening, 18 reported using the G-suite in education for three years or less. Therefore, this might explain why the majority of teachers are still in the early stages of the CBAM framework. However, these findings still show the majority of teachers at the school have used the platform for at least a year, therefore teachers at the school should not be considered new adopters of the platform, which contradicts the reported SoC. As presented in Table 2.3, this was confirmed using a chi-square test, which suggested no statistical significance when comparing CBAM stages to the number of years teaching at the school. Likewise, the same statistical analysis did not reveal a statistical significance with reported SoC and reported access to professional development, gender, or number of years teaching at the school.

Table 2.2

Frequency Table for Teachers

Variable	Value					
Gender		Male	Female			
	35	14	21			
PD		Yes	No			
	35	10	25			
Yrs User		Novice	Inter.	Old Hand	Past User	
	34	1	20	12	1	
Yrs G-Suite		1 yr	2 yr	3 yr	4 yr	5+
	35	5	2	11	9	8
Yrs at School		1 yr	2 yrs	3 yrs	4 yrs	
	35	3	7	7	18	
Yrs Teaching		1-2 yrs	3-5 yrs	5+ yrs		
	35	2	9	24		

Note: Frequency to measure number of years using the G-suite platform in education (yrs G-Suite), how many teachers considered themselves a non-user, novice, intermediate, etc. (yrs User), number of years teaching (yrs Teaching), and number of years teaching at the school (yrs at School).

Advised caution is needed when making inferences about CBAM stages and reported professional development on the G-suite. Google products are prominently workshopped during teacher conferences, and significant resources for these applications exist online. Therefore, teachers who actively attend or seek out information about the G-suite may have accessed more information through less formal methods of professional learning not captured on the survey. However, analysis of the data still suggests that attending or not attending formal professional development using the platform has made little impact on concerns toward the G-suite. This finding might explain why four years after using the technology, most teachers at the school still consider themselves intermediates (= 20), as opposed to old hands (n=12). Remaining participants considered themselves a past-hand (n=1) and a novice (n=1) while the final participant left this question blank.

Table 2.3

Chi-Square test to compare CBAM SoC

Compared to	Value	Df	Asymp. Sig.
Gender	2.917	6	.819
Years Teaching	6.635	12	.881
Years at School	18.444	18	.427
Years Using G-Suite	17.969	24	.805
Professional Development	5.110	6	.530
N of Valid Cases	35		

Note: Correlation is significant at p = <.05

Discussion

The needs assessment conducted at the research site investigated teachers' primary concerns four years after the introduction of the G-suite. It also considered whether an emphasis on the individual is justified from the perspective of increasing teacher creativity using the G-suite platform. The framework for this investigation utilized the concerns-based adoption model to measure teacher change. Teachers who expressed concerns toward the latter stages of the framework are likely to be using the technology, and therefore opportunities for teacher creativity using the platform exist at the school. However, if results indicate concerns in the lower stages of the CBAM framework, teachers are less likely to be using the technology. Therefore, there is a need to engage teachers in its use before promoting teacher creativity utilizing the technology.

Against expectations, the results found most teachers at the school expressed concerns for the first stage of the CBAM framework. Other prominent concerns seemed to indicate little use of the platform. This finding was surprising given that most teachers reported using the platform for at least three years (n=28), which is close to the suggested time needed for full adoption of an innovation (Hall & Hord, 2015; Rogers, 2003). However, an alternative viewpoint considers whether these results indicate the use of less known applications within the G-suite, as opposed to popular tools such as Google docs. Whatever view held, the outcome for this study remains the same. An opportunity to promote valued changes in practice using the technology remain at the school four years after its introduction into the community.

Data analysis comparing categorical variables to an individual's stage of concerns suggested no statistical significance. Therefore, an individual's access to professional development for technology doesn't support the increased use of the G-suite platform. Neither does more years using the platform, or more years working at the school. Considering this result, a future intervention designed to promote teacher creativity using new technology may need to find other ways to support changes in practice other than focusing exclusively on running how-to workshops for varying Google applications. Instead, an intervention that focuses on the individual remains a viable focus for future investigation.

Furthermore, presenting the G-suite as a platform containing multiple applications may help teachers separate applications they know well, versus applications they know less well. As a sociocultural view of creativity considers connections to new and existing affordances (Glaveanu, 2013), this type of perspective may assist teachers using a new application, as it promotes use alongside existing technology that is already part of established routines. Likewise, the prominence of Google in education (Singer, 2017b) has led to the development of a variety of applications that work in conjunction with

Google's education platform. Therefore, encouraging teachers to explore new applications compatible with tools in the G-suite might also accommodate teachers who expressed concerns in the later stages of the CBAM framework.

Finally, although the CBAM framework serves an investigation into teacher creativity from the perspective of measuring progress over the bridge, it doesn't include information toward creative outcomes as defined in this study. Consequently, there is a need to expand upon this research to add more significant support for teacher creativity when using the G-suite. As a valued change in practice serves as a core component of this construct, teachers must develop the capacity to evaluate outcomes they produce using the technology. Without this capacity, it remains possible that teachers will create novel experiences using the platform. However, these outcomes may not contribute to creativity unless there is evidence that a valued change in practice has occurred. Securing a framework to guide this extra layer is an essential expansion of this study. Therefore, it forms the basis for the second synthesis of literature presented in the next chapter.

Limitations

There are three significant limitations in this study; the first relates to the introduction of the G-suite as part of the formation of a new school. Roger's (2003) refers to innovation as something new to a community, and the CBAM framework measured adoption of this type of innovation (Straub, 2009). However, although emphasis on the technology and its use within a new environment support this concept of innovation from one perspective, when viewed from another, the introduction of the platform didn't contribute as something new to the community as the community didn't exist when the platform was introduced.

The second limitation is the experience participants had with the G-suite in education before the technology was used at the school. Although we measured the population's progress over four years, our survey results suggest that teachers have been using the application for much longer. Consequently, reported stages of concern might be a result of factors that exist outside this current school environment. However, as no relationship was found between the stages of concern and the number of years using the platform the importance of the change process within the individual potentially reduces the impact of this limitation.

The final limitation of this investigation was the absence of more internal factors that might influence stages of concern. Considerations may include personality traits, a teacher's sense of self-efficacy, pedagogical beliefs, and a greater understanding toward cultural factors that exist in the school. Furthermore, not including a question that captured subject taught meant that it wasn't possible to investigate if teacher concerns aligned to departments within the community. Some of these limitations will need to be addressed when studying the impact of the intervention, as the literature review from the first chapter suggested these are influential factors for change and technology use in the classroom. However, as the CBAM framework explores change at the individual level (Hall & Hord, 2015), maintaining this theoretical framework within the study continues to provide a viable way to measure how an individual teacher is responding to the challenge of producing creative outcomes using new technology.

Chapter 3: Promoting Teacher Creativity

In chapter one, we explored the introduction of new technology as an opportunity for a teacher to make a change in practice. We examined this event from a creativity perspective by presenting new technology as a potential affordance that should be used to produce new and useful outcomes within the context of teaching and learning. However, without creativity at the individual level, meaningful change within a teacher's practice is unlikely. Consequently, resources committed to technology procurement and training will not provide a suitable return on investment.

The initial review of the literature investigated the impact of first and second-order barriers on effective technology use, and consequently, the production of creative outcomes with new technology. Although many first-order barriers exist in a teacher's environment, the research suggests second-order barriers are particularly influential (e.g., attitude and self-efficacy). Therefore, the goal of this study is to promote creativity with technology at the practitioner level by supporting teachers who are challenged to use new technology without sufficient information or training. Devoting attention to this particular scenario is considered important as research shows it is a common experience for teachers working in public education. Furthermore, there is little research that investigates this concept from a creativity perspective (Bramwell et al., 2011). Therefore, this second review of literature will explore connections to creativity and teacher change, concluding with a proposed intervention to promote teacher creativity using new technology.

Needs Assessment

For the needs assessment conducted in chapter two, we adopted the CBAM framework to investigate teacher concerns for the G-Suite platform four years after its introduction at an urban middle school in Connecticut. The CBAM framework was selected because it offered a way to measure the change process from the teacher's perspective, and consequently served as an indicator for teacher creativity. This is because concerns that do not indicate progress in technology adoption, suggest no change, and subsequently no creative outcome.

Opportunities for Future Study

Using empirical findings of the needs assessment, we inferred that a significant proportion of teachers at the school expressed concerns typical of introducing new technology into a community. There was also an indication that a smaller group of teachers had begun to adopt the G-suite but remained concerned about the impact on existing practices. In contrast, a third group had made some advancement with the technology by expressing concerns related to collaboration with others and expanding the use of the technology. Given the length of time the platform has existed at the school, these findings were surprising. Nevertheless, overall concerns expressed toward the technology still indicated interest or existing use of the platform, and therefore an opportunity to promote teacher creativity using the G-suite.

Revisiting Teacher Creativity

The Five-A framework, presented in chapter one, continues to inform the conceptual framework for this study. The framework presents the teacher as the individual actor challenged to use the G-suite, and the G-suite serves as a technological affordance that exists within the teacher’s environment. Actions undertaken by the teacher will determine what changes in practice occur as a consequence of this technology, and the outcomes produced from these actions are what is evaluated as being new and useful for the teacher.

Actions Undertaken

When deliberately working toward a creative outcome with new technology, the actor must respond to the challenge of change. Different theoretical perspectives agree that the perception of affordances offered by new technology will influence a person's actions toward the adoption and use of the technology. Without adoption, a teacher is unlikely to make a change in practice, and consequently will not produce a creative outcome using the technology. This section considers different theoretical perspectives that may inform actions undertaken by the teacher.

Innovation theory. Innovation Diffusion theory presents the perceived attributes of an innovation as one of five factors that contribute to an individual's decision to adopt something new within their professional practice (Rogers, 2003). This concept speaks directly to how a teacher compares the new to the old – more specifically will the new technology perform better than what they already have or use (Al-Gahtani, 2003; Liao & Lu, 2008). This view also exists within Davis's (1989) Technology Acceptance Model, which presents the perceived usefulness and perceived ease of use as factors that will influence a person's actions toward adoption (Bhatiasevi & Naglis, 2016; Joo, Park, & Lim, 2018). However, research has suggested varying levels of self-efficacy may also contribute to how these perceptions are constructed by the individual (Scherer, Siddiq, & Tondeur, 2019). Nevertheless, these theories indicate a need to address how teachers initially view technology introduced as a consequence of an authority innovation-decision. This could subsequently help address the influence of self-efficacy (Scherer et al., 2019), which was identified in chapter one as a prominent second-order barrier for technology use in the classroom.

Teacher change. Smith, Stair, Blackburn, and Easley (2018), consider how diffusion theory may contribute to an improved understanding of teacher change, which Guskey (2002) considers to be an outcome of a change in attitude. In an expanding upon the Interconnected Model of Professional Growth, Clarke and Hollingsworth's (2002) explore this relationship further. They highlight how teacher change is a cyclical process of ongoing reflection and enactment. After receiving an external stimulus such as a request to use a new technology, a teacher engages in this cyclical process within four domains; personal domain, domain of practice, domain of consequence, and external domain. Extensive evaluation of this model is beyond the scope of this study; however, Clarke and Hollingsworth (2002) expand on the belief that teachers must make valued connections between the proposed change and their professional domain. Only a positive outcome from this experience can result in a change in attitude toward the proposed innovation (i.e., technology), and consequently actions that will contribute toward a change in practice.

Furthermore, within this model, Clarke and Hollingsworth present teacher growth as an iterative process situated within a teacher's professional context. Consequently, a one-off technology-focused professional development session is unlikely to produce meaningful change if the teacher is unable to make valued connections between the technology and how it aligns to their individual situation. Instead, promoting change using new technology should be seen as part of a teacher's professional growth, which encourages ongoing reflection and experimentation (Clarke & Hollingsworth, 2002). This type of experience can begin with a nudge toward helping teachers make valued connections to applications in the G-suite, but sustained change is a consequence of ongoing personal discovery and experience (Clarke & Hollingsworth, 2002; Guskey, 2002).

Ill-Defined Problems

Promoting an ongoing process of experimentation and reflection would address the constant technological changes taking place within education. However, to promote this type of professional growth, a teacher must develop the necessarily skills to address the ill-defined problems that arise when new technology is thrust into a teacher's practice without adequate vision or training. An ill-defined problem is particularly daunting because the immediate steps and final outcome are unknown to the practitioner (Buchanan, 1992; Rowe, 1991). Some of these problems are documented within the research into first and second-order barriers. They include support within existing IT infrastructure (Hsu, 2016; Zheng, Wang, Doll, Deng, & Williams, 2018), lack of technology leadership (Esplin, Stewart, & Thurston, 2018), and working against perceived time constraints (Tondeur, van Braak, Ertmer, & Ottenbreit-Leftwich, 2017). Furthermore, workshops can contribute toward technology barriers in education (Bissonnette & Caprino, 2015; Ryan & Bagley, 2015; Sugar & Warren, 2003), which vary in perceptions of effectiveness even from teachers within the same discipline (Telese, 2012). For example, a generic workshop on Google docs might present best practices as viewed by a social studies teacher. Still, this success might be attributed to adequate IT support, existing student knowledge of the application, and small class size.

Consequently, another social science teacher working in different conditions might not perceive this example in the same way. If they are unable to make the connection, they must then work to address the question, what is the value of this technology for me? This question might be why some teachers view technology as an "add-on" to their existing classroom responsibilities. (Cassidy, 1998, p. 182).

Vongkulluksn, Xie, & Bowman (2018), state that the introduction of new technology must address value beliefs among the teaching population. In an extensive study that surveyed 624 teachers across grades six through twelve, Vongkulluksn et al., found value beliefs to be an influential factor in technology use and perceived support from the administration. This finding continues to support the need to promote actions that help teachers identify connections between a new technology and the specific conditions that exist within an individual's practice. Furthermore, this approach may help teachers take greater leadership during the change process (Ertmer et al., 2012). The remaining sections are dedicated to the development of a conceptual framework that will inform an intervention to promote teacher creativity using new technology. The intervention will consider ways to engage teachers in an ongoing process of reflection and enactment, while also working to improve value beliefs toward the use of new technology.

Attitudes for Teacher Creativity

Adopting a designer's mindset is one potential avenue to explore when working to address ill-defined problems introduced as a consequence of technological disruption (Koehler & Punya, 2005). Tsai and Chai (2012), compare the ability – or rather inability – for teachers to think like designers as being a new "third-order barrier" in the research for technology integration (p. 1059). They argue that overcoming this barrier is essential because it provides teachers with the capacity to resolve first and second-order barriers explored in the previous chapters. Design works to develop solutions for ill-defined problems and may help connect new technology to existing value beliefs. This perspective may also help transition the concept of change as something introduced by an authority, and toward an outcome controlled by the teacher as part of their ongoing professional growth.

A Design Mindset

In a qualitative research project that investigated a sample of designers from leading U.S. design firms, Michlewski (2008) identified a collection of prominent design attitudes that support a design culture in organizations where ill-defined problems were common. He referred to this collection of attitudes as a design mindset. Koh, Chai, Hong, and Tsai (2014), applied Michlewski's findings to an investigation into how teachers developed knowledge of new technology within their practice. Working on the bases that instructors already have the expertise of their subject matter and an understanding of pedagogy, they investigated the development of technological knowledge through learning experiences that take place within the social context of the teacher's working environment (i.e., the classroom). Their investigation found a lack of learning through design when working to integrate new technology in the classroom. They concluded that teachers would benefit from professional learning experiences that teach them how to think more like designers when challenged to use new technology in their practice.

Adopting a design mindset may offer a way to address some of the challenges introduced when teachers are tasked with using new technology, as it promotes attitudes that can support the type of actions needed to bring about meaningful change within an individualized practice. As shown in Table 3.1, these attitudes address ambiguity concerns, make connections to what already exists within a teacher's environment, and promote technology as a tool that can be used to improve the learning experience.

Table 3.1

Design Attitude for Teacher Creativity

Design Attitudes	Defining the Construct for Teacher Creativity
Consolidating multidimensional meanings	Connecting new technology to what already exists within a teacher's environment (e.g., existing technology, tools, routines, etc.). Using these connections to produce new and useful outcomes in practice.
Creating, bringing to life	The combination of idea-finding and solution-finding in response to a problem situated within a teacher's professional practice. This includes the ability to engage in actions that explore and new ideas.
Embracing the discontinuity and open-mindedness	The ability to address a change event with little information or guidance on what constitutes as a successful use of a new technology.
Making it useful	The ability to reflect on ideas based on those that bring about value within a teacher's practice (i.e., Considering the value to the learning experience, as well as the "coolness" factor associated with creating and making with new technology).
Engaging empathy	Considering how ideas interact with members of the teacher's environment, including students, teachers, and administrators.

Note: Constructs identified by Michlewski (2008) and modified to address circumstances within a teacher's environment.

Connecting Attitudes for Design and Creativity

At this point in the dissertation, it is helpful to make an explicit connection to design attitudes and attitudes toward teacher creativity. This study explores the latter as actions taken or not taken by the teacher, as well as the outcomes produced as a consequence of those actions. When considering the context of applying teacher creativity to support a meaningful change using technology, we are discussing the design of technological solutions specific to a teacher's context. How one teacher uses Google docs may be similar to another teacher, but it also could be drastically different. This is because it depends on the problems they are working to address, and that process, is a process of design. The actions taken in this process are actions similarly taken by designers, who typically work with an intent to solve a problem (Glaveanu et al., 2013). In this study, we are working to increase the number of creative outcomes produced with new technology introduced as a consequence of an authority innovation-decision. In this section, we are making connections to design attitudes as they are synonymous with teacher creativity. Consequently, promoting a positive attitude toward design encourages a positive attitude toward teacher creativity, as they both constitute actions that produce creative outcomes in response to an ill-defined problem.

Without adequate attitudes in place, teachers are less likely to engage in the type of actions that support the creative uses of technology (Bower, Highfield, Furney, & Mowbray, 2013). For example, Bower, Highfield, Furney, and Mowbray (2013) investigated the transformation of two pre-service teacher education programs that explored how design thinking principles might assist instructors when tasked with using new technology. The study found that these actions were not embraced wholeheartedly by the population. However, within the findings the importance of mentorship was highlighted, and there were indications that participant attitudes toward technology had changed. For example, participant perceptions for technology had transitioned away from seeing it "as a tool they ought to use' to something they could "enthusiastically and purposefully" design with to improve student learning experiences (p. 47). This specific finding embraces the concept of meaningful change with technology, as it is less about using the technology and more about discovering what value it may bring to an individual's practice.

Plucker and Dow (2010), have explored a model for creativity enhancement that focuses on a change in attitude as a precursor for creativity. Although research into this model is ongoing, an investigation within a course on creativity showed that it is possible to promote changes in attitude toward creativity. For example, at the beginning of the course, the majority of students believed constraints hinder creativity, however at the end of the course only 37% maintained this attitude; 33% had changed their position to seeing constraints as something that assist or resist creativity, while 23% stated constraints support creativity (Plucker & Dow, 2016). These findings contribute to the concept of teacher creativity because a change in attitude might influence the perception of external barriers (e.g., time constraints), and are also required to bring about change (Guskey, 2002). Table 3.2 presents some of the creativity attitudes explored by Plucker and Dow (2016) and modified in support of teacher creativity.

Table 3.2

Attitudes Toward Teacher Creativity

Creativity Attitudes	Defining the Construct
Constraints	Teacher attitudes toward constraints considers what they belief about classroom constraints (e.g., time, technology access, curriculum, routines, etc.).
Marketing	Teacher attitudes toward marketing new and useful outcomes to other members of the school community (e.g., teachers, administrators, parents, etc.). Examples of marketing might include presentations at faculty meetings and speaking at education conferences.
Failure	Teacher attitudes toward professional failure, as experienced within the classroom environment. Specifically, do teachers consider failure as something that can support teacher creativity or negatively impact teacher creativity.
Understanding	The concept of creativity is interpreted in many ways (Plucker et al., 2004). Therefore, encouraging teachers to view this construct as something that can support a meaningful change in practice is critical to this investigation. This includes attitudes to whether you can increase creativity and whether creativity generalizes to other professions or subjects.
Teacher Evaluations	Support from the administration is a factor that impacts teacher change in the classroom. Therefore, how do teachers view teacher evaluations; do they consider them as something that can support teacher creativity or are they something that inhibits teacher creativity.

Note: Attitudes identified by Plucker & Dow (2016) and modified to accommodate the context of this investigation.

Actions for Teacher Creativity

The creative process and design process are often associated with a collection of actions conducted by a group or individual (Glaveanu et al., 2013). Within sociocultural theory, a practitioner's appropriate actions should be situated within a specific context (Gee, 2008). Therefore, a painter's creative process applies to them painting a painting within their studio. This process might vary depending on the materials they use and whether they are working collaboratively with others. Likewise, the evaluation of those actions and the outcome produced as a consequence of those actions remain situated to when, where, and how the final painting is presented. Glaveanu (2012), highlights that the process of creativity is prompted by different stimuli, which considers "habitual creativity", "improvisational creativity", and "innovative creativity" (p. 86). The latter is most suitable for this study because it considers the type of process prompted by an intent to solve a problem in a new way. This perspective of action is strengthened further by findings of an empirical study conducted by Glaveanu et al., (2013), which investigated the creative actions of 60 practitioners across five domains. Findings showed that designers tended to engage in a creative process from the perspective of solving a client's problem. This problem benefits from the clarification of a client's brief, which outlines the project's intended outcome.

Although there are varying perspectives to explore when it comes to the concept of teacher creativity, this dissertation study promotes the production of new and useful outcomes that contribute to meaningful changes within a teacher’s practice. Therefore, the type of actions we want to encourage within the process are those that can assist teachers in identifying and resolving problems situated within a classroom environment. Likewise, we want to establish an intent to solve a problem in practice, which will improve the learning experience for with the student or the teacher. Consequently, when considering a new technology as an affordance introduced into a teacher's environment, an intervention should not focus solely on expanding the use of that technology. Instead, it should help the teacher identify problems that such an affordance could help address. This action may then increase value beliefs toward that technology, and consequently increase adoption and meaningful change in the classroom.

Furthermore, we must support teachers in measuring the outcomes they produce as a result of these actions, from the problem they intend to solve. The inclusion of this approach supports the belief that teachers can lead the change within their practice by placing responsibility for identifying how best to use the technology firmly at the feet of the teacher (Vahasantanen, 2015). Equipped with a set of creative actions that support problem-solving, a teacher is in a much better position to respond when presented with this type of challenge.

Approaches to Creative Problem-Solving

Although described as a messy process (Juelsbo, Tanggard, & Glaveanu, 2018), creativity can benefit from specific methodological approaches like creative problem-solving (CPS). This approach attempts to structure the experience with a predetermined sequence of strategies that assist in the design and development of a solution (Juelsbo et al., 2018). These varying, though similar approaches to creativity, offer an insight into the type of actions that may support teacher creativity in the classroom.

Likewise, differing forms of Design Thinking is proving particularly popular at this current time (see IBM Design Thinking, IDEO Design Thinking, & Design Thinking 101). Although it is difficult to attribute design thinking to one individual, many of its early references emerged from design disciplines (Buchanan, 1992; Churchman, 1967; 1974; Rittel 1987). Within creativity research, the phrase creative design thinking has also received attention (Darbellay, Moody, & Lubart, 2018). Darbellay, Moody, and Lubart (2018) highlight that the inclusion of the word creative suggests an intent to produce an original outcome. This particular statement may contribute to a future debate that expands beyond this study's scope. Nevertheless, it signifies that a review of varying processes that support design and creativity remain ongoing within the literature.

Common Principles of CPS and Design Thinking

Understanding research into the creative process can provide insight into what actions might assist teachers as they work toward a creative outcome using new technology. Many of the procedures commonly associated with CPS methods align with those first outlined in Osborn's *Applied Imagination: Principles and Procedures of Creative Problem-Solving* (1963); however, thirty years before the publication of this book, German physicist Graham Wallas presented a four-step process for creativity in *The Art of Thought* (1926). Wallas presented the creative process as a journey with a beginning, middle, and end. The first stage, referred to as preparation, is when the actor investigates all possible directions associated with the problem. The second stage is incubation, and the third is illumination. These later stages represented a period when ideas made their way from the subconscious to a place where the individual could actively consider them. The final stage, added later in Wallas’s work, is verification, which consists of actions that produce deliberate modifications to the original idea.

Similar to Wallas, Osborn identified distinct stages within a linear progression, which consisted of fact-finding, idea-finding, and solution-finding. Fact-finding represents the stage where information is gathered, and a clearly defined problem is identified; idea-finding is where practitioners generate and consider ideas to address the problem, and solution-finding is when ideas are selected and finalized for implementation. Osborn also presented thinking strategies to accompany an individual or group as they make their way along the journey. These included focusing on quantity over quality, welcoming unusual ideas, withholding judgment, and combining and synthesizing information. These techniques support divergent and convergent thinking skills, which are considered important attributes of individuals engaged in the process (Osborn, 1963). For example, divergent thinking is regularly highlighted as a creativity skill, and often used to measure a person's creative thinking ability (George & Zhou, 2001; Koehler et al., 2011; McCrae, 1994; Runco, Plucker, & Lim, 2001; Torrance & Safter, 1999). Whereas convergent thinking is considered equally important (Cropley, 2006; Puccio et al., 2018), especially within research into how metacognition contributes to the creative process by helping individuals choose ideas most likely to succeed (Kaufman, Beghetto, & Watson, 2016; Hargrove, 2012; Hargrove & Nietfeld, 2014).

Other models that build or share close similarities to Osborn's work include the Universal Traveler (Koberg & Bagnall, 1972), and the Thinking Skills Model (Puccio, Murdock, & Mance, 2011). The standard procedures found in CPS are also present within popular Design Thinking strategies, such as Ideo's Design Thinking (IDEO Design Thinking) and Nielsen Norman Group's Design Thinking 101 (Norman Group). For example, IDEO's Design Thinking asks practitioners to emphasize and define a problem before generating ideas. Although this process is conducted from the perspective of learning about the problem from the perspective of the user, it remains consistent with

Osborn's fact-finding objective. Likewise, the subsequent emphasis on prototyping is familiar to design thinking practitioners, though perhaps less evident within CPS (Worwood & Plucker, 2018). However, the overall objective of prototyping remains aligned to Osborn's overall concept of solution-finding, which constitutes actions that ready an idea for implementation.

Puccio et al. (2018), conducted a study to investigate whether a group of people trained in CPS, were better at producing creative solutions to an ill-defined problem. The study found that those trained in CPS were more effective at divergent and convergent thinking tasks, while also being more likely to produce better solutions than those in a group with members not trained in CPS. Furthermore, the study found that participants who performed minimum levels of CPS, stilled perform better than those who did not apply any form of CPS. Therefore, even minimal training in CPS may help increase the number of creative outcomes a teacher produces when challenged to use new technology. For the interests of this study, Table 3.3, uses Osborn's fact-finding, idea-finding, and solution-finding stages to group common CPS principals and design thinking stages together. Of particular importance is the initial stage of fact-finding, which may assist teachers in connecting the technology to problems considered relevant within their practice. Whereas the latter stage may prove helpful in guiding the type of experimentation and reflection presented by Clarke and Hollingsworth (2002).

Table 3.3

Principles of CPS and Design Thinking

	Fact-Finding	Idea-Finding	Solution-Finding

Art of Thought (Wallas, 1926)	Preparation	Incubation/ Illumination	Verification
Universal Traveler, (Koberg & Bagnall, 1972)	Analyze/Define	Ideate/Select	Select/Implement
Thinking Skills Model (Puccio, Murdock, & Mance, 2007, 2011)	Clarification: Exploring the Vision/Formulating Challenges	Transformation: Formulating Ideas	Transformation: Formulating Solutions
CPS Stages and Phases (Treffinger, Isaksen, & Stead-Dorval, 2006)	Understanding the Challenge: Constructing Opportunities, Exploring Data, Framing Problems	Generating Ideas	Preparing for Action: Developing Solutions, Building Acceptance
IDEO Design Thinking	Empathy/Define	Ideate/Prototype	Prototype/Test
Nielsen Norman Group	Empathy/Define	Ideate/Prototype	Prototype/Test/ Implement

Note: Common principles found in CPS and Design Thinking methods, grouped by Alex Osborne's (1960) Creative Problem-Solving.

Fact-Finding

Fact-finding considers actions associated with clarifying the problem, which helps narrow down a focus applicable to a teacher's context. Encouraging a teacher to identify what they want to accomplish with the technology can help a teacher ask the right questions about their environment, including an exploration of affordances that already exist within their environment. If completed successfully, this process will "tame" the "wicked" elements of an ill-defined problem (Churchman, 1967, p. 141), by establishing a destination for the journey a teacher is about to begin. After completion of this process, a teacher would have connected technology to a problem situated within their practice. This connection may also influence existing value beliefs toward the challenge, as situating the technology within a teacher's environment reduces ambiguity and helps elevate the value because the outcome is now firmly connected to something of interest to the teacher.

Idea-Finding

Once identifying a problem of practice, the next step is to generate ideas on how to reach the intended destination. This is where the application of divergent thinking is particularly helpful because it helps teachers "produce and consider many alternatives" with new and existing affordances within their environment (Torrance & Safter, 1999). Kim, Kim, Lee, Spector, and DeMeester (2013) found the perceived usefulness of new technology was determined by how the teacher viewed the technology within their existing belief system. With an identified problem of practice firmly established, a teacher can generate ideas on how to connect that technology to their practice. Consequently, it should continue to align with their existing belief system. However, there is also the danger that teachers will generate ideas in support of current practices, which would contradict the goals of this study. This concern is evident in the use of interactive whiteboards. The initial perception of this technology was a replacement for the chalkboard (Betcher & Lee, 2009). Although they could serve this function, the new affordances they offered were significantly more. Despite this, the use of interactive whiteboards has continued to vary (de Silva et al., 2016), with some teachers still perceiving them in a way similar to that of a chalkboard (Rafalow, 2014). New technological affordances have lots of potential uses in school, but evidence suggests their application is dependent on the ideas generated by the teacher. Therefore, when a teacher identifies a problem in practice to address, they must also consider multiple ways to solve that problem. This will increase the number of ideas for how best to use a new technology when working to solve a problem, and consequently increase incidents of originality and creativity (Acar, Burnett, & Cabra, 2017; Runco & Acar, 2012; Puccio et al., 2018).

Within the concept of idea-finding, Osborn promotes group ideation activities, such as brainstorming. These types of ideation techniques help divergent thinking by encouraging practitioners to welcome unusual ideas, withholding judgment, focus on quantity over quality, and combining and synthesize information (Osborn, 1963). Many of these principles remain common in today's CPS, and Design Thinking methods. However, recent research has focused more on social factors that might impede this experience when working within groups (Coursey, Paulus, Williams, & Kenworthy, 2018; Paulus, Korde, Dickson, Carmeli, Cohen-Meitar, 2015). Subsequently, a combination of individual and group ideation is now considered more conducive for creativity (Korde & Paulus, 2017). Therefore, although professional learning standards encourage collaboration among colleagues (Swan Dagen, & Bean, 2014), the process of producing creative outcomes to address problems of practice should not exclude opportunities for teachers to generate ideas alone.

Solution-Finding

The final stage of the CPS process addresses the stage where ideas transition into workable solutions (Osborn, 1963). Rather than thinking divergently (i.e., focusing on generating lots of new ideas), this stage depends on convergent thinking. This aspect of the process requires the application of judgment to determine the most appropriate way to address the problem (Osborn, 1963). Having adequate knowledge of pedagogical practices and subject matter is essential at this stage (Koehler et al., 2011; Koehler & Mishra, 2005). Without this knowledge, a teacher practitioner cannot adequately evaluate ideas from the perspective of their likely success when implemented within the context. As stated by Cropley (2006), convergent thinking serves the creative process, because it "leads to a single best answer and [...] leaves no room for ambiguity" (p. 391).

The selection of ideas includes modification and refinement, which takes place as a practitioner engages in exploration within the classroom. This aspect of the solution-finding stage addresses this concept of tinkering, which is considered important when working toward a new and useful outcome (Hargreaves, 1999; Kaufman & Beghetto, 2009; Koehler et al., 2011). Known in the design world as prototyping (Kelly & Littman, 2001), this action introduces some additional considerations within the overall process of promoting teacher creativity. First, tinkering can serve aspects of the idea-finding stage of the creative process, while also contributing to an iterative cycle of experimentation and reflection promoted by Clarke and Hollingsworth (2002). This realization highlights some of the challenges to consider when presenting any type of creative process as a linear progression. Although there is a sequential order to the proposed stages, a teacher may need to modify their journey as more information becomes available (Juelsbo et al., 2018). Second, experimentation in the class introduces the possibility that a teacher will experience incidents of failure. Although the concept of failure forms part of the process, it does not always lead to a learning event within some professional environments (Cannon & Edmondson, 2005). Furthermore, within education, an experience of failure may negatively impact a teacher's sense of self-efficacy (Krueger & Dickson, 1994). Therefore, any type of tinkering should utilize a teacher’s existing knowledge of the situation and comfort in the process.

Creative Outcomes

The actions explored in this chapter support the production of a creative outcome using new technology. Previously, we have presented these outcomes as a new product or learning experience that improves upon an existing situation. This remains consistent with the definition of creativity, which emphasizes the social context (Plucker et al., 2004). The inclusion of this element within the definition of creativity aligns to the Five A framework; Glaveanu (2013) refers to observed outcomes as an artifact, which is evaluated and measured based on what already exists in the environment. Therefore, outcomes produced as a consequence of the teacher's actions must consider their function within the school's community and how they are perceived by the individual and other people familiar with the community (e.g., colleagues).

There is extensive research to support evaluations of creativity, and the varying theoretical approaches extend beyond the scope of this dissertation. However, as Runco, Plucker, and Lim (2001) highlight, creativity evaluations usually focus on ideas or products produced during or after the process. For example, the Runco Ideational Behavior Scale is an instrument designed to measure divergent thinking (Runco et al., 2001; Runco et al., 2014), which was explored earlier in the chapter, and supports the generation of ideas. Runco et al. (2014) present divergent thinking as a product that can be observed and measured more generally than a final product, as the latter is specific to a domain and requires a level of expertise and understanding of the context. Other work expands into the evaluation of ideas (Gibson & Mumford, 2013; Mumford, Devin, Lonergan, & Scott, 2002), which are considered necessary in the process because although ideation is helpful, there is a need to remove those that are unrealistic or unlikely to succeed (Cropely, 2006). This aspect of the process was addressed in the previous section. Nevertheless, emphasizing the importance of a teacher's ability to select ideas with the highest potential to succeed remains a crucial part of this study because it contributes to the production of creative ideas while protecting the teacher from harmful incidents of failure.

Furthermore, as this study promotes meaningful change with technology, it is insufficient to attribute an idea as a representative of change, as this is counteracting to the problem this dissertation is working to address – new and useful *uses* of technology. Nevertheless, ideas should not be discounted because they may signify an emerging outcome that will eventually transition into a successful intervention. The next section introduces a framework that will help teachers evaluate outcomes from the perspective of measuring ideas based on the newness and usefulness they bring to the school community, while also acknowledging a developmental relationship between emerging ideas and fully realized solutions.

4-C Framework

Building upon the concept of big-c, little-c (see Merrotsy, 2013), Kaufman and Beghetto (2009) present four unique categories of creativity. These categories consider the extent to which the outcome is new and useful to the individual creator. How others perceive the outcome within the immediate environment, and finally, how the outcome impacts existing systems within the school and broader community. As presented in the first column of Table 3.4, the 4-C model helps categorize outcomes based on mini-c, little-c, pro-c, or big-c. The latter considers outcomes at the level of those produced by famous scientists, inventors, and entrepreneurs, and will not be addressed in the following discussion (see Kaufman & Beghetto, 2009).

Through empirical investigation, Kaufman and Beghetto (2013) have shown that individuals absent scholarly knowledge of creativity can distinguish between the different levels of creativity as presented within the 4-C framework. This finding is replicated in other empirical studies that have shown similar results under the same conditions (Puente-Diaz, Maier, Brem, & Cavazos-Arroyo, 2016; Puryear, 2016). Although, the context of this dissertation study is different than the research referenced above, the 4-C model is still considered a useful tool to support teacher creativity using new technology.

Table 3.4

4-C Model of Creativity

	Five-A Framework	Teacher Creativity
Mini C	Considers individual accomplishment within a learning process (e.g., learning to play the piano for the first time)	Teacher and colleagues perceive the outcome a personal achievement that delivers something new and useful when compared to the individual's existing practice
Little C	New and useful accomplishments that others within the social context can identify and appreciate	Teacher and colleagues perceive the outcome as new and useful when comparing to existing practices in the school as a whole

Pro C	Considered as expert level. Builds on substantial knowledge-base to produce outcomes that change existing paradigms	Teacher and colleagues identify incidents that suggest the outcome has begun to challenge existing paradigms within the school or wider district
Big C	Transformational outcomes that deliver far-reaching change that extends beyond the life-time of the individual	N/A

Note: Occurrences of big-c creativity expand beyond the concept of teacher creativity, as explored within this study.

Mini-c. As shown in Figure 3.1, mini-c captures an individual's personal accomplishment as a consequence of a learning event (Kaufman et al., 2013). The newness and usefulness of the outcome are captured at the individual level and do not expand any further (Beghetto & Kaufman, 2007). This view of creativity is particularly helpful when investigating young children's creativity, who routinely produce creative outcomes as they formulate and explore new ideas about their world. Although these discoveries are likely known, and therefore come with little value to others, they remain creative when viewed from the individual's perspective. The inclusion of mini-c within the 4-C framework, offers a developmental aspect to teacher creativity using new technology, as mini-c creativity can eventually progress to little-c, and eventually pro-c creativity (Kaufman & Beghetto, 2009). This would occur as the teacher expands their experience with the technology and begins to produce outcomes that are recognized and adopted by other members within the community.

When applying the concept of mini-c to teacher creativity, we measure meaningful changes of practice, as viewed through the eyes of the teacher. Promoting this perspective would allow the teacher to judge whether the outcome produced constitutes something new and useful within their environment. From this perspective, it is acceptable to acknowledge ideas as an outcome of teacher creativity, as although not enacted, they can still contribute as a new and useful outcome that may produce a meaningful change in the future (Kaufman & Beghetto, 2007). Furthermore. mini-c captures enacted ideas that might already be common outside the teacher's classroom, though when viewed exclusively from the individual's perspective, they constitute as being new and useful for that person.

Little c. Little-c has a history of representing the everyday acts of creativity that do not constitute significant changes within a domain but remain essential to the immediate context (Kaufman & Beghetto, 2009). The individual's expertise might be limited at this stage of the process, so the outcome is unlikely to constitute a significant change within the community. Nevertheless, others with direct knowledge of the context can recognize these acts of creativity, which might promote some replication among colleagues. Therefore, an outcome deemed fitting of little-c is new and useful because other people within the school (e.g., fellow teachers) relate to the idea or problem addressed. Consequently, little-C requires people, other than the individual teacher, to share the same perspective of the outcome. This requires people to have knowledge of the context, so they can establish an understanding of the problem the teacher is working to address, and adequately cast judgment on whether they share the same view of the outcome.

Pro-c. The final category to consider within the context of this study is new outcomes perceived as having value to the broader education community. Kaufman and Beghetto (2009) believe pro-c creativity to encompass outcomes that change paradigms within a field. Typically, this would require extensive expertise obtained through years of service, and then applying this expertise to make significant changes to how an aspect of a domain operates.

In the interest of this study however, we reduce the impact of this outcome to the broader school community, such as the district or state. Yet, Kaufman and Beghetto (2013b) have discovered some overlap between interpretations of little-c and pro-c creativity, and therefore a more considerable distinction is required. As professional standards for learning promote evidence-based changes (Learning Forward, 2013), we present pro-c creativity as an improvement in practice that is supported by evidence, and subsequently advocated by the administration and actively adopted by colleagues.

Figure 4.1: 4-C Framework

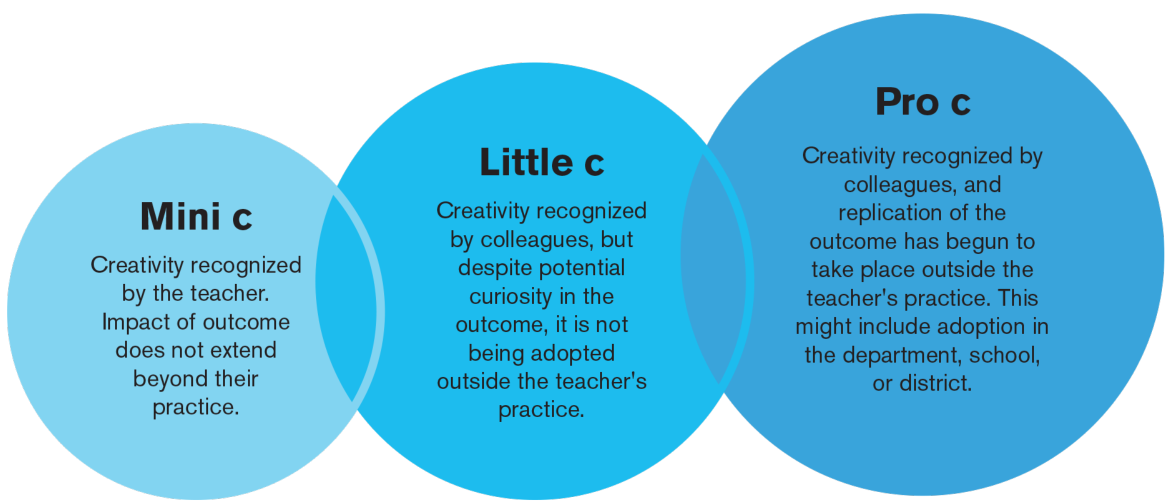

Figure 3.1: Building on the 4-C framework for creativity (Kaufman & Beghetto, 2013), mini-c, little-c, and pro-c, contribute to progressing levels of teacher creativity. Big-c is not considered applicable within the context of this investigation.

Teacher Reflection

A final aspect to creative outcomes, is the reflection that is conducted by the teacher during their journey toward a meaningful change in practice using new technology. The 4-C framework offers an opportunity to categorize teacher creativity at multiple levels while also introducing a developmental approach to the process. Actively reflecting on outcomes can help teachers move from the mini-c level to the little-c level, and potentially to the pro-c level after gaining a level of expertise in the technology and problem they're working to address. This linear progression occurs through "playing with one's creativity in a domain and improving through experimentation" (Kaufman & Beghetto, 2009, p. 7). This connects to the concept that change and teacher creativity is a journey that requires constant course corrections along the way. These corrections occur as a consequence of learning through experience. They also continue to complement a model for teacher professional growth, while revisiting the concept of a design mindset and actions such as exploring ideas within the environment. Without opportunities to explore the technology and apply it to the problem, it is unlikely we will see a novice user of the technology progress beyond little-c.

As teachers engage in actions that lead to course corrections, there is a need to reflect on their experiences, so that essential discoveries and judgments are made about the technology. This process of self-monitoring one's learning during the exploration of an idea is a critical component of education and falls under the general scope of metacognition (Veenman, 2017). Metacognition, which is a theory of learning (see Flavell, 1979), is known to positively impact creative thinking in students (Delclos & Harrington, 1991; Hargrove, 2012). It is also relevant when promoting actions for teacher creativity, as individuals must understand when and where to apply those actions

(Sternberg, 1998). In a quasi-experimental study conducted by Hargrove and Nietfeld (2014), metacognition proved influential for design students engaged in CPS. After receiving training in specific metacognitive strategies, students in the treatment group performed better at divergent thinking tasks. These students also produced a higher quality product as judged by a panel of external experts. The study focused specifically on raising awareness of creative strategies and self-monitoring their application during the process.

Metacognition also supports the identification and selection of ideas considered to have the most significant potential for success (Puccio et al., 2018). Kaufman, Beghetto, and Watson (2016) have explored how creative metacognition supports young students in evaluating ideas using the 4-C framework. They found that children were able to identify the outcomes they produced by mini-c and little-c, supporting earlier findings with college students who were also able to distinguish the difference (Kaufman & Beghetto, 2013). However, in the latter study, it should be noted that students found it challenging to separate little-c and pro-c, which is a finding applied earlier in this section. In contrast, the previous study suggested potential difficulties in recognizing outcomes in domains outside drawing.

Specific to informing judgement within teacher creativity using new technology, an exploratory study by Demir and Sahin (2014), showed the role metacognition played with preservice science teachers who were challenged to design a science toy. The study found that participants of the challenge did generate different ideas for the toy and took time to select an idea that they believed would be the most effective. However, the study also suggested that preservice teachers may be more likely to pursue hunches and not reflect too much on ideas that weren't selected. This is something to consider when challenging teachers to use new technology in the classroom. At the same time, hunches might contribute to the selection process, helping teachers reflect on ideas based on those most likely to produce the intended outcome. Therefore, the 4-C framework not only offers a way to evaluate outcomes produced using new technology, but it may also help teachers to grasp the different levels of creativity better as they reflect on the ideas they generate during the process.

Four Actions for Teacher Creativity

The process, depicted in Figure 3.2, shows four actions to support teacher creativity using new technology. The actions incorporate governing principles commonly found in CPS and Design Thinking, while also encouraging an ongoing reflection of ideas and outcomes throughout the process. The first action, *Choose Destination*, addresses the ambiguity when technology is introduced without an adequate vision or sufficient training, while also addressing value beliefs. It promotes divergent thinking, where teachers examine different problems before using convergent thinking to identify the most suitable to address using the technology. The second action, *Chart Course*, takes place when an understanding of the technology is established, and a clear plan of execution exists. At this stage of the process, the teacher has an intended outcome associated with solving a problem within their teaching and learning environment. *Course Correct* captures the exploration that follows as an idea is implemented in the classroom. Here teachers evaluate the technology from the perspective of whether it is adequately addressing the problem that they are working to address. During this time, teachers play with the technology and modifications are made similar to that of a designer prototyping a product. Self-monitoring becomes critical at this stage, as teachers must learn from failure, and resist the temptation to abandon the effort because it isn't working as intended. A teacher who embraces a design mindset should also consider failure as part of a creative process that provides essential information used to refine and improve upon an idea (Goodwin, Low Ling, Ng Tee, Yeung, & Cai, 2015). This leads into a combined action at the end called *Reflect*, which is when a teacher evaluates the outcome based on its newness and usefulness. Here they are challenged to articulate with colleagues whether they produced a new outcome within their practice, while also determining whether they adequately addressed the problem they intended to address.

The combination of names for each action is meant to represent the concept of a journey, which must conclude. Consequently, the actions represent a linear approach like those found in CPS and design thinking methods; however, the drastic bends within the lines is designed to signify that the journey is not immediately apparent and will require changes as knowledge about the technology increases. This concept builds on Koehler and colleagues' work, who present a process of "adapting, reusing, and repurposing new technology" (Koehler et al., 2011, p. 149). This is accomplished by combining emerging technological knowledge with existing pedagogical and content knowledge. This relationship takes place as teachers engage in divergent and convergent thinking within the chart course, and course correct stages. Furthermore, placing course correct, behind chart course, illustrates that participants on the journey may feel that they are going backward as they make their way toward their final destination.

Figure 3.2: Four Actions for Teacher Creativity

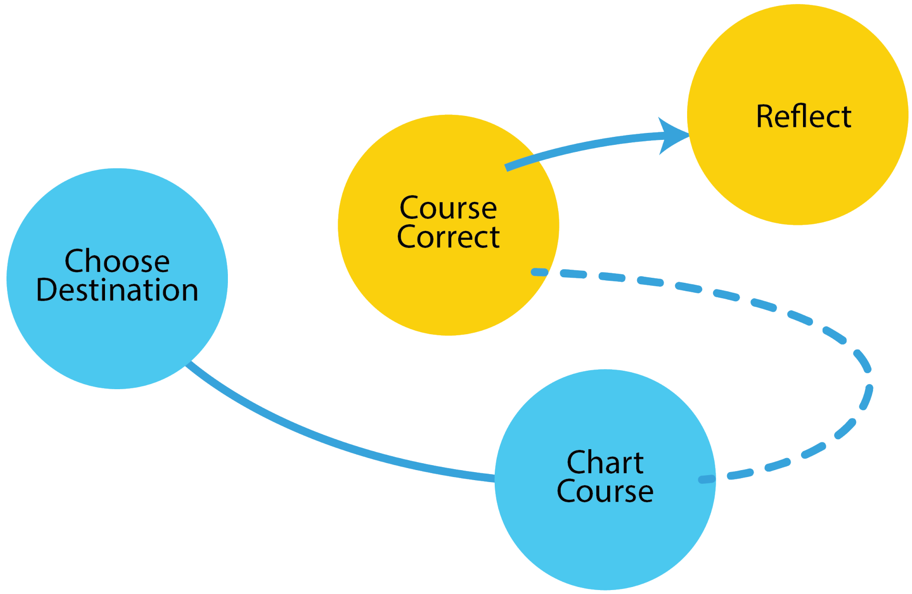

Figure 3.2: Four Actions for Teacher Creativity, incorporate common principles found in CPS and design thinking, while also addressing an understanding toward teacher change and the concept of value beliefs.

Discussion

In this chapter, we continued to position a change in practice using new technology as a creative process that can benefit from strategies that support teachers in navigating their way through ill-defined problems. We examined standard procedures within CPS and design thinking, as well as creativity research that offers ways to measure outcomes. This review contributed to the identification of four actions that support teacher creativity using new technology. The first action choose destination, address the ambiguity that arises during the introduction of new technology, but also enhances the value of the technology and, subsequently, a desire to learn.

We also explored how a design mindset might improve attitudes toward creativity and the process of producing a new and useful outcome that constitutes a change in practice. Although not explicitly represented within the four actions of teacher creativity, approaching these actions like a designer will hopefully help teachers to consider challenges experienced during the exploration of new technology as part of the process and consequently help address first and second-order barrier concerns (Tsai & Chai, 2012).

The four actions presented in this chapter will inform the development of a professional learning program that promotes teacher creativity using new technology. The 4-C framework will assist in presenting creative outcomes as a developmental process that begins with mini-c and hopefully progresses to little-c. Furthermore, the 4-C framework accommodates different levels of creativity, which might be more comforting to any teacher that struggles with the concept while also giving everyone an understanding of what constitutes a creative outcome within their practice.

Finally, this approach to technology use in the classroom complements Hargreaves (1999) vision of the knowledge-creating school, where professional knowledge is generated and validated within the institution. In likening the classroom to an R&D unit at a technology company, Hargreaves (1999) argues that teachers should be encouraged to produce knowledge by tinkering within their practice. This same word is applied by Kaufman and Beghetto (2009), who consider tinkering as something that supports progress across the 4-C framework. The concept of an R&D unit, located within a teacher's classroom, encourages a culture of teacher creativity, including experimentation of ideas and learning through failure, which also draws another connection to the design world. It also supports a cycle of professional learning, which presents technology not as an "add-on" (Cassidy, 1998, p. 182), but as an opportunity to change within an ongoing developmental process where an individual constantly works to improve their practice and obtain mastery of a new technological affordance within their environment (Clarke & Hollingsworth, 2002).

As we consider the findings of our two literature reviews, we close with the following three propositions:

1. Introducing technology alone is not enough to produce an improved change in practice.
2. The challenge to produce an improved change in practice using technology is an ill-defined problem that requires teachers to think like designers and engage in deliberate actions that promote teacher creativity.
3. Teacher creativity can support teachers as they work toward a meaningful change in practice.

In the following chapter, we present our intervention and final study to determine if we can support this position using empirical evidence.

Chapter 4: Class of 2032: Design the Future

This study investigates teacher creativity using new technology, and whether this approach assists teachers when challenged to make a change in practice as a consequence of a new technology introduced by an authority innovation-decision. In this study teacher creativity is presented as actions taken or not taken in response to a problem, and outcomes produced as a consequence of those actions. This view aligns to a process of design, as the actions represent a journey typically taken by designers. Therefore, technology inserted into a teacher's environment is a new tool that provides the teacher with additional affordances that can assist in the design of solutions, rather than a tool that produces an immediate change in practice. The extent to which they participate in a deliberate process to discover and implement solutions using new technology is what constitutes teacher creativity within the context of this dissertation study.

Building on varying approaches to creative problem-solving and design thinking (Koberg & Bagnall, 1972; Osborn, 1963; Puccio, Murdock, & Mance, 2007, 2011), chapter three presented four actions for teacher creativity. It also introduced a framework to guide the evaluation of outcomes using a developmental approach to creativity. Rather than viewing a creative outcome through one perspective, we first considered how it is perceived by the individual teacher, followed by colleagues, and then the impact it has on the broader school community. This approach to evaluating outcomes recognizes that creativity is a developmental process that increases with more knowledge, experience, and expertise. This conceptual framework for teacher creativity informed the design of an intervention to promote creative exploration of applications available in the G-suite. The final two chapters discuss the implementation of this intervention at an inner-city middle school in Connecticut.

Class of 2032: Design the Future

Class of 2032: Design the Future (C2032), was developed to promote the four actions of teacher creativity when challenged to use new technology. Participants were taught how to apply these actions through a sequence of workshops (see Appendix B). Hereby referred to as the C2032 challenge, the program presented a change event designed to replicate an authority innovation-decision. The challenge tasked teachers to produce a creative outcome using one G-suite application they know well, and another G-suite application they haven't used before within their professional context. After initially presenting the challenge to the principle and teachers at the school, there was a request to modify the task to accommodate other applications that worked alongside the G-suite. As a consequence, the C2032 challenge as implemented required teachers to produce a creative outcome using one app from the G-suite they know well, and another application accessible with a Google account that they haven't used before. The change to the latter part of the challenge allowed teachers to expand beyond from G-suite.

Table 4.1

Four Actions of Teacher Creativity (Treatment)

Workshops	Goal
Orientation	Introduce Challenge
Choose Destination	Clarify Problem
Chart Course	Produce Problem-Statement

Course Correct	Learn from failure. Make modifications to idea
Reflect	Reflect on idea/outcome. Does it adequately address the identified problem

Note: The four actions of teacher creativity served as an intervention to promote teacher creativity using new technology.

After reviewing the challenge and exploring the 4-C framework presented as a way to measure creative outcomes, participants engaged in a sequence of workshops dedicated to each of the four actions for teacher creativity. As presented in Table 4.1, the first workshop addressed the first action, Choose Destination, the second workshop covered Chart Course, and the final two workshops were Course Correct and Reflect. These four workshops represent the intervention under investigation in this study.

Purpose of Study

The intervention works to promote creativity when teachers are tasked with responding to new technology introduced as a consequence of an authority innovation-decision. This topic is considered relevant as methods used for technology procurement do not prioritize evidence-based research in the decision-making process, and consequently teachers must assume responsibility for identifying how best to integrate these tools into their environment. Without a commitment to use the technology to produce outcomes that improve the learning experience, it is likely that technology investments will continue to be wasted (Cuban, 2013). Therefore, the C2032 program will provide an opportunity to explore teacher creativity as a way to support a meaningful change in practice when technology is introduced into a teacher's environment. C2032, is an intervention developed to support teachers through this process by engaging them in a sequence of actions associated with creative problem-solving and design thinking. The intervention was piloted at an inner-city school in Connecticut using a mixed methods research design to address the following two research questions:

RQ1: Does the four actions for teacher creativity support change using a new application associated with the G-suite?

RQ2: How does participation in C2032 influence teacher creativity when using new applications associated with the G-suite?

Research Design

The study incorporated a quasi-experimental mixed method convergent design to investigate the two research questions (see Figure 4.1). Including a treatment and comparison group is indicative of an experimental study where an invention is given to one group and withheld from the other (Creswell & Plano-Clark, 2018). However, implementing the study at a single research site required a pragmatic approach to accommodate the various needs at the school. This situation naturally challenged the capacity to control for extraneous variables, while also influencing the instruments used to collect data.

As a construct, creativity remains a subjective concept (Plucker et al., 2004; Plucker & Makel, 2010), therefore a mixed-methods study was appropriate to examine this concept as it combined the use of quantitative and qualitative instruments to provide maximum insight into this phenomena during the intervention (Creswell & Plano-Clark, 2018; Johnson & Onwuegbuzie, 2004). Quantitative tools helped determine if the intervention influenced teacher change, but the qualitative data provided an overall insight into why aspects of the implementation worked or didn’t work (Mertons, 2018).

Following Creswell and Plano-Clark (2018), a convergent design also meant quantitative and qualitative data was collected concurrently using a pre and post-program survey instrument. However, the quantitative and qualitative data gathered from this survey remained separate until the end of the program, which is when it was analyzed and eventually merged into a joint display table presented in chapter five. A sequence of interviews took place with members of the comparison and treatment group. Participants of these interviews received a document containing an initial summary of qualitative findings. These individuals then provided input on this document as part of a member checking strategy that improved overall validity of the study, while providing greater insight into some of the themes that emerged during analysis (Creswell & Miller, 2000).

Figure 4.1. Study Design

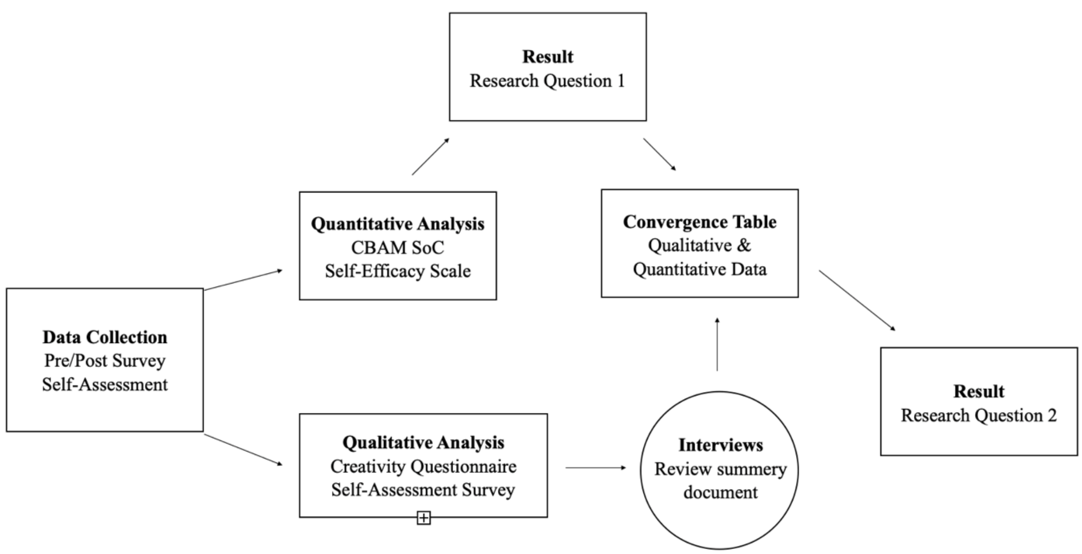

Figure 4.1. Mixed-methods quasi-experimental research design used to investigate teacher creativity using applications associated with the G-suite platform. Quantitative data addresses research question 1, and quantitative and qualitative data addresses research question 2.

Outcome Evaluation

Workshops that engaged members of the treatment group included the four actions for teacher creativity, while members of the comparison group received a learning experience focused on sharing and discussing examples. Consequently, the outcome evaluation considered whether teachers who received the treatment performed better in the C2032 challenge than those who did not receive the treatment. However, making valid inferences toward the impact of this treatment required efforts to account for varying confounding variables. A confounding variable is a factor that might influence the outcomes under study, and consequently weaken inferences made about the impact of an intervention (Guba, 1981). Leviton & Lipsey (2007) highlight that the intension of intervention research is to infer that action taken to address a problem caused the observed changes, as opposed to unaccounted extraneous variables. Attempts were made to address some of these variables within the study design, which also considered how best to limit confounding variables during workshops. Other considered factors were included in the program's theory of treatment (e.g., self-efficacy) or addressed during the process evaluation (see Figure 4.2).

Figure 4.2: Theory of Treatment

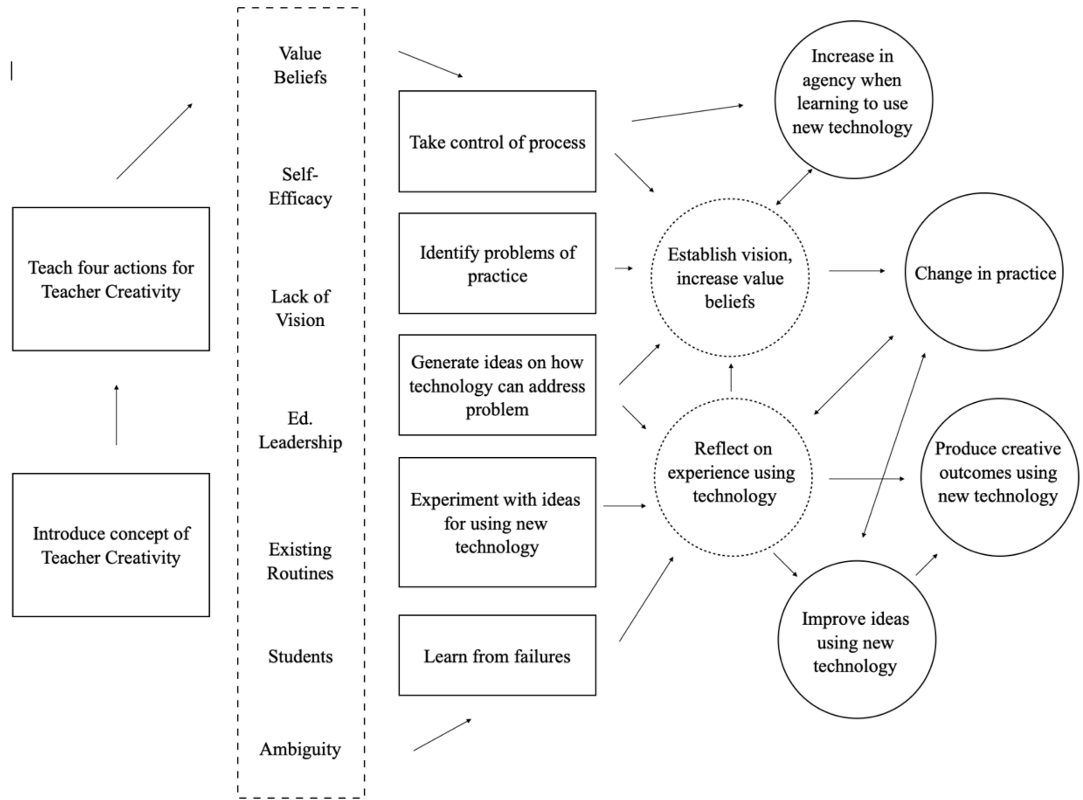

Figure 4.2. Theory of treatment presents a path to change and creative outcomes using new technology.

Process Evaluation

A study's design must incorporate methods to monitor a program's implementation when investigating its effectiveness. This aspect of an investigation is referred to as program fidelity and explores whether participants are experiencing the program as designed (Dusenbury, Brannigan, Falco, & Hansen, 2003). Without data to support program fidelity, any inferences made about its outcome are significantly weakened, because there is little evidence to support claims that observed results were a consequence of program participation, and not a confounding variable (Baranowski & Stables, 2000).

When evaluating program fidelity, Dusenbury, Brannigan, Falco, and Hansen (2003) present a collection of strategies to monitor program evaluation. Dose considers how much of the program a participant has received; adherence investigates how critical components of the program are implemented; quality of delivery considers what participants thought of instructional activities, and responsiveness monitors overall engagement. As C2032 is part of the school's professional development program for the 2019/2020 academic year, teachers were required to participate, which addressed dosage. However, initial ideas to monitor adherence through observations, formal interviews, and requiring journals were considered too time-consuming for participants. Likewise, there was a concern that teachers might perceive observations negatively.

Consequently, data gathered in support of a process evaluation was primarily collected using short surveys administered at the end of each workshop. These surveys included closed questions to monitor delivery quality and open-ended questions to investigate adherence and responsiveness. Together, these surveys addressed the following three process evaluation questions:

RQ3: How does the experience of the C2032 program vary among the comparison and treatment groups?

RQ4: How do attitudes about the C2032 program change during implementation?

RQ5: To what extent are members of the treatment group engaged in the four actions for teacher creativity?

Methods

Participants

The study takes place at an inner-city middle school in Connecticut. The school provided access to the researcher, while also being perceived as a suitable research site for study because teachers were using a technology introduced as a consequence of an authority innovation decision. The school contains approximately 690 students and 43 certified teachers across grades six through eight, of which 28 are considered core teachers, and 15 are special area teachers and school counselors. The student population is 321 White, 249 Hispanic, 57 Asian, 49 African American, and 18 are Multiracial. Approximately half of the student population (n=366) is on free or reduced lunch.

Every teacher at the school participated in the C2032 program as part of the school's professional development schedule. Teachers were invited to complete surveys as part of a corresponding study to investigate teacher creativity using new technology. There were 33 respondents of the pre-survey and 32 respondents of the post-survey. However, when preparing data for analysis, only 15 teachers were identified as fully completing the pre and post-survey. This eventual sample included eight members of the treatment group and seven members from the comparison group. Of these 15 participants, nine were female, six were male, 13 were white, and two were African American. The majority of the participants indicated they had taught for over five years, with only two selecting 3-5 years and one selecting 1-2 years.

Sampling Methods. As a quasi-experimental study, the program consisted of a treatment group and a comparison group. A stratified random technique placed all participants into one of the two groups. This approach was appropriate as cultural differences among different groups within a school community can influence how a teacher responds to the introduction of new technology (Ertmer & Ottenbreit-Leftwich, 2010). This research is relevant because the study took place within an academy school, where some tracks place a greater focus on technology use. Furthermore, this variable was absent from the initial needs assessment and therefore, might serve as a confounding variable for teachers responding to the C2032 challenge. Consequently, teachers were grouped first by subject and then randomly assigned to either the treatment or comparison group.

A teacher's age and years in service are also known to influence the use of new technology (Blackwell et al., 2014; Ritzhaupt, Dawson, & Cavanaugh, 2012). However, the needs assessment results did not indicate a relationship between these variables and teacher placement on CBAM stages of concern. Therefore, the stratified random sampling technique did not address these two variables.

Instruments

A pre and post-program survey containing open and closed questions was the primary instrument used to collect data from participants in this study. Limiting data collection to this single instrument was considered appropriate because teachers expressed concerns about observations, and the principal had communicated a desire to limit the time needed for teachers to provide data. The survey consisted of 71 items, which included questions to gather demographics, followed by the CBAM SoC questionnaire, then the short version of the Teachers' Sense of Self-Efficacy questionnaire (see Appendix C). An open-ended teacher creativity questionnaire was the final section of the pre and post-survey, which captured changes in attitudes toward creativity (see Appendix D). The pre-survey was completed electronically before the first workshop, and the post-survey was completed electronically two weeks before the program finished. Administering the post-survey two weeks before participants completed the challenge is a limitation discussed in the final chapter.

Five short surveys were also created and administered electronically at the end of each workshop to address the process evaluation questions. Four of these surveys were identical across the treatment and comparison groups (see Appendix E); however, the final survey was slightly modified to include specific references related to the four actions of teacher creativity (see Appendix F). This survey helped address the last process evaluation question. A self-assessment survey was also added to the study after discomfort was expressed by teachers toward evaluations of the C2032 challenge (see Appendix G). Initially, the study design incorporated a small group of external evaluators who would use a creativity rubric to determine if outcomes produced by teachers constituted as mini-C, little-C, or pro-C creativity. This assessment would contribute data to determine if members of the treatment group had produced a higher quantity of creative outcomes than the members of the comparison group. Instead, this aspect of the study was conducted using a self-assessment survey and administered as part of a whole group activity. As a consequence of self-reporting assessments, this aspect of the investigation forms another limitation discussed in the final chapter.

CBAM. To address the first research question, the CBAM SoC measured teacher change using new applications associated with the G-suite. This instrument requires substituting the word innovation with the intervention under investigation (George et al., 2013). Consequently, when completing the questionnaire, participants were asked about their concerns about the C2032 challenge. As discussed in chapter two, capturing teacher concerns using the CBAM framework contributes to measuring teacher creativity, as concerns represent an individual's progress during the change process. There are 35 items on the CBAM instrument, representing seven stages of concern. These stages fall into four clusters; unrelated, self, task, and impact. A teacher with high concerns in the unrelated stage is preoccupied with other responsibilities, while high concerns in the self-stage suggest interest in participating in the C2032 challenge. High concerns in the task stage would most likely signify active participation in the C2032 challenge, and the use of a new application associated with the G-suite. While high concerns in the impact cluster would indicate progress toward change. Chapter two provides further information about the items contained in this instrument and how they apply to teacher creativity.

Having participants respond to concern statements about the C2032 challenge was considered the best approach for this investigation, as specifying a specific technology wasn't possible under the challenge conditions. Furthermore, the challenge itself expands the focus beyond technology adoption alone and includes concerns toward the concept of teacher creativity and working toward a change in practice. However, the variations in how teachers perceive the introduction of something new (Spillane et al., 2002), is a limitation of this approach, as some teachers might consider the C2032 challenge from the perspective of producing a creative outcome. Whereas others might focus on the use of new technology. Consequently, this limitation is considered addressing the qualitative data.

Teacher Creativity Questionnaire. The teacher creativity questionnaire captured changes in attitude toward concepts associated with creative problem-solving and design thinking. This instrument also helped capture differences in how participants perceived the construct teacher creativity before and after the program. The questionnaire was modified from Plucker and Dow (2010; 2016), who used a similar instrument to investigate changes in student attitudes toward creativity before and after taking a course on the topic. The questionnaire measured participant beliefs toward some of the stereotypes associated with creativity (e.g., people are either born creative or uncreative) and considered how these beliefs influence a person's overall attitude toward the construct. The teacher creativity questionnaire used in this study, integrated some of the same questions used by Plucker and Dow, for example, it includes can we increase creativity, or are you just born with it; what is the relationship between constraints and creativity, and are individuals or groups more creative when working on a project. Other items from this questionnaire were modified to fit the context; for example, how does evaluation influence creativity, was changed to how does teacher evaluation influence creativity. Likewise, what is the relationship between constraints and creativity changed to what is the relationship between classroom constraints and teacher creativity? Furthermore, the questionnaire addressed the concept of failure, which is not only associated with an iterative design process (Maltese, Simpson, & Anderson, 2018) but something that can negatively influence an individual's decision to adopt something new (Fevre, 2014).

Self-Assessment. A creative outcome rubric was designed using the 4-C framework as a guide. The rubric helped reduce some of the ambiguity toward the challenge and encourage consensus among the participants using the rubric. The instrument incorporated one short statement to measure, mini-c, little-c, and pro-c creativity while limiting options to a yes or no response (see Appendix H). During the presentation of the rubric, concerns toward a feeling of judgement were expressed by participants. This led to modifications in language and a decision not to involve a group of external professionals to evaluate outcomes produced from the C2032 challenge. This initial approach was seen as an effective way to measure and compare the number of creative outcomes; however, as a result of this decision, the creativity rubric was transformed into a self-assessment survey (see Appendix G). This led to an activity where teachers from the same subject area, evaluated each other's ideas using the creativity rubric as a guide to facilitate feedback.

Teachers' Sense of Self-Efficacy. The first and second literature review indicated self-efficacy may serve as a confounding variable during technology integration (Lee & Tsai, 2010) and teacher change in the classroom (Tschannen-Moran & Chen, 2014; Tschannen-Moran & McMaster, 2009). It may also influence teachers' creativity as they respond to the conditions of the challenge (Jaussi, Randel, & Dionne, 2007; Tierney & Farmer, 2002). Therefore, the teachers' sense of efficacy scale (see Tschannen-Moran & Woolfolk Hoy, 2001) was selected to compare how this factor differed among members of the comparison group and treatment group. This specific instrument has an established research base (Mehdinezhad & Mansouri, 2016; Yoo, 2016) and offered a way to measure this construct within the context of a teaching and learning environment (Tschannen-Moran & McMaster, 2009). Although the self-efficacy level would likely vary among participants, the inclusion of this instrument provided a way to monitor variations by group.

Procedure

Intervention

The C2032 challenge is an ill-defined problem designed to replicate some of the ambiguity that arises when tasked with using new technology introduced as a consequence of an authority innovation-decision. As presented in chapter three, the treatment consists of guiding teachers through four actions of teacher creativity, which incorporate core principles of creative problem-solving and design thinking. These actions consist of

1. Choose Destination, which guides teachers through identifying a problem of practice that they want to address;
2. Chart Course, which challenges teachers to identify new technology they think can adequately address the problem;
3. Course Correct is when teachers begin to experience failures and, subsequently, modify their idea; and
4. Reflect, which is when teachers consider whether the outcome adequately addresses the problem they intended to address.

These four actions represented the treatment given to one group and withheld from another. In keeping with quasi-experimental research design, all other experiences during the program's implementation were intended to remain the same (see Table 4.3).

Time. Ertmer and Newby (2013) highlight that learning designers should incorporate different instructional theories to accommodate multiple perspectives on learning when developing a learning experience. The Carroll model (1989) informs us that time - as a factor in education - is critical to achievement. This concept considers the actual time available for learning and the actual time spent on learning. Applying this to the intervention, we consider the length of the C2032 workshops, as well as the duration of the program, and time for teachers to work on the C2032 challenge. As the program took place as part of the school's monthly full faculty PD blocks, participants of the control group and treatment group experienced equal time in the program. Furthermore, although workshops will have different instructors, collaborative planning ahead of time delivered the same length of presentation and activities, even if the content was modified or facilitated by a different instructor.

Regarding the actual time, teachers spent learning in the program will likely vary by individual. However, adult learning theory emphasizes the need for teachers to perceive value in the learning experience (Rohlwing & Spelman, 2014), which is a position equally shared by instructional design theorists (Richey, Klein, & Tracy, 2011). Consequently, before teachers were separated into their respective groups, a joint orientation session was conducted to use Keller's ARCS model (1983) to evoke equal curiosity for the challenge.

Problem-Based. Jonassren's (1997) problem-based approach to instruction facilitates learning through a design-based challenge that addresses an ill-structured problem. This strategy encourages the learner to develop and engage procedural knowledge toward a real-world problem, including reflecting on the learning taking place during this experience (Richey et al, 2011). Assuming a problem-based approach to the challenge, meant both groups were engaged in a similar learning experience. Likewise, efforts were consistently made to address questions related to the challenge as a whole group, which typically took place before workshop sessions. However, opponents of problem-based learning have questioned the lack of guidance offered as part of this instructional approach (Kirschner, Sweller, & Clark, 2006), particularly within activities with minimal guidance (Sweller, Kirschner, & Clark, 2007). Therefore, although using problem-based instruction across both groups provided an opportunity to control for some variables, it introduced an unintended extraneous variable associated with the lack of guidance in the comparison group. Consequently, while the treatment group received training in clarifying their problem, the comparison group was presented with a list of associated G-suite applications already used by colleagues in the school. This approach was considered a suitable alternative to the guidance offered within the treatment group.

Collaboration. Adult learning theory promotes learning experiences that facilitate active engagement among colleagues (Rohlwing & Spelman, 2014), which is equally promoted within formal standards for professional learning (Swan Dagen & Bean, 2014), and reported as something teacher's value (Curwood, 2014; Kuh, 2016). Therefore, workshops for both the comparison group and the treatment group consisted of activities that engaged teachers in collaborative exercises in every session. Collaborative activities experienced by members of the treatment group centered on the four actions for teacher creativity, while collaborative activities in the comparison group focused on the discussion of ideas, examples, and technology. This framework remained consistent throughout the program, with facilitators of each workshop speaking for 10-15 minutes, followed by a 30-40-minute activity (see Appendix I).

Table 4.2

Summary of Program

Key ID Approaches	Duration	Date	Treatment	Control
ARCS Model/ Problem-Based Learning	1 hr.	Oct. 2020	Orientation	Same

Problem-Based Learning /Collaboration	1 hr.	Oct. 2020	Choose Destination	Alternative
Problem-Based Learning /Collaboration	1 hr.	Oct. 2020	Chart Course	Alternative
Problem-Based Learning /Collaboration	1 hr.	Dec. 2020	Course Correct	Alternative
Problem-Based Learning /Collaboration	1 hr.	Feb. 2020	Reflect	Alternative
Working Session	2 hr.	Feb. 2020	Working session	Same
Collaboration	1 hr.	Mar. 2020	Self-Assessment	Same

Note: Learning approaches implemented for C2032 workshops

Data Collection

Pre/Post Survey. As presented in the matrix shown in Table 4.3, pre and post-program survey was electronically presented to all participants at the beginning and toward the end of the C2032 program. When presented with the survey, teachers were reminded that their participation in the study was completely voluntary. This verbal announcement was made as some teachers at the very beginning of the program inquired about the difference between participation in the study, and participation in the C0232 program. The survey was completed after an introductory presentation about the C2032 challenge, which provided teachers with initial information about this proposed innovation. This was considered a helpful way to address SoC statements about the C2032 challenge. However, it did mean that teachers were introduced to the concept of teacher creativity before completing the pre-survey.

Workshop Surveys. At the end of each workshop, members of the treatment and comparison group were given a separate link to a workshop survey. As these surveys intended to monitor program implementation, it was determined that every teacher would be invited to complete the survey. This decision addressed an essential aspect of IRB protocol, as excluding or isolating the feedback from non-participants of the study may have left them at a disadvantage to participants of study. In total, there were four structured workshops, which had an identical survey that captured feelings toward the quality of instruction and monitored changes in attitudes toward the C2032 challenge. There was also another short survey administered at the beginning of an open workshop that took place toward the end of the program. Teachers had requested this additional session during the previous workshop because they wanted more time to work on the C2032 challenge. In total, there were five short surveys administered in the program, which provided data to address the process evaluation questions.

Self-Assessment. As discussed in the previous section, a self-assessment survey designed from the creativity rubric evaluated outcomes produced for the C2032 challenge. The self-assessment survey was completed after a one-hour activity where teachers discussed their idea with colleagues. The teacher creativity rubric was used to facilitate this discussion by helping teachers evaluate outcomes based on the newness and usefulness of their idea when compared to what already existed in their classroom. After consultation with members of the treatment and comparison groups, it was determined that the evaluations of outcomes should take place as one large group, with small group discussions organized by subject.

The evaluation of outcomes was initially scheduled during a two-hour professional development block in February. This extended session was identified early in the year because it provided time to facilitate a thorough deliberation of outcomes among colleagues, while also providing sufficient time to complete the post-program survey. However, this block of time was given up accommodating the teachers' request to have free time to work on projects. Therefore, the only alternative time left to complete the evaluation of outcomes was within the standard one-hour monthly professional development blocks. Therefore, when facilitating discussion among colleagues, a rigid schedule of 15-minutes per idea was implemented among three groups. Furthermore, as the program progressed, it became apparent that each subject area's level of knowledge was required to provide adequate feedback. Consequently, teachers were organized into pre-assigned subject groups, which led to mixed treatment and comparison group participants. This introduced a confounding variable, as participants engaged in reflective conversations about ideas based on their varying experiences in the program. The final chapter discusses the limitations of administering the self-assessment under these conditions, which is a concern only to the self-assessment survey, as the post-survey took place two weeks before.

Interviews. Creswell and Miller (2000), emphasize the need for researchers to include methods that address reliability concerns when conducting mixed-methods research. Therefore, the initial study design incorporated focus group interviews as a method to support the triangulation of the qualitative data. During the study's implementation, schools were closed as a consequence of the Covid-19 pandemic. Consequently, it was not possible to complete this aspect of the intended design. As an alternative, an email was sent to teachers at the school, asking if they would be willing to participate in a 1-hour semi-structured interview to provide feedback on a summary document. Securing participation for an interview under these conditions was challenging, however, the study secured two volunteers from the treatment group, and a volunteer from the comparison group. A fourth interview took place with a teacher who helped facilitate workshops for the comparison group. Therefore, qualitative findings in this study were reviewed by two teachers for each group.

Table 4.3

Data Collection Matrix (Process and Outcome Evaluation)

Outcome Evaluation	Construct	Tool	Frequency	Analysis
Does the four actions for teacher creativity support change using a new application associated with the G-suite?	Change	CBAM, SoC	Pre and post	T-Test
How does participation in C2032 influence teacher creativity when using new applications associated with the G-suite?	Teacher Creativity	CBAM, SoC	Pre and post	T-Test
How does participation in C2032 influence teacher creativity when using new applications associated with the G-suite?	Teacher Creativity	Teacher Creativity Questionnaire	Pre and Post	Deductive coding/ In vivo coding
How does participation in C2032 influence teacher creativity when using new applications associated with the G-suite?	Teacher Creativity	Self-Assessment survey	Final workshop	Deductive coding/ In vivo coding

How does participation in C2032 influence teacher creativity when using new applications associated with the G-suite?	Teacher Creativity	Semi-Structured Interviews	Post-program	Deductive coding/ In vivo coding
How do attitudes about the C2032 program change during implementation?	Participant Responsive ness	Short Survey	Administered at end of each workshop, for a total of four times	In vivo coding
How does the experience of the C2032 program vary among members of the comparison and treatment group?	Quality of delivery	Short Survey	Administered at end of each workshop, for a total of four times	T-Test
To what extent are members of the treatment group engaging in the four actions for teacher creativity?	Adherence	Short Survey	Administered at the beginning of a workshop, for a total of one time.	In vivo coding

Note: Matrix presents the five research questions for this study and the procedures used to address those questions.

Data Analysis

First research question. As shown in Table 4.6, quantitative data from the SoC questionnaire addressed the first research question. Before conducting the analysis of this question, all data from the pre/post surveys were downloaded into an excel spreadsheet. Participants with missing entries in either of the three items were excluded from the study. Respondent data for the pre and post-survey was also not tagged successfully; therefore, demographic information addressed this issue when preparing data for analysis.

This process resulted in data representing eight participants from the treatment group and seven participants from the comparison group.

To determine what impact the intervention had on the change process, total raw scores for each of the seven scales of the CBAM stages of concern were turned into percentiles using a scoring chart from George et al., (2013). The average percentile score in each of the seven stages was then calculated and used to generate an overall profile for each group. Using SoC percentiles to generate group profiles is primarily conducted in two ways (2006); the first is to group individuals by the stage where they expressed the greatest concern (George et al., 2006), and the second is to average percentile scores for each stage across the group (Donovan & Green, 2010). As the SoC was only implemented at the beginning and end of a short program, the latter was selected because it was considered more sensitive to changes in scores than changes in stages. Furthermore, analyzing the average percentiles scores for each stage was deemed appropriate as the number of participants in each group were not identical. Percentile scores contributed to a line graph that visually compared changes between the pre and post-survey. George et al., (2013) and Hall and Hord (2015), which provides information on how to interpret scores from CBAM instruments, was used as guide to interpret results.

The Teachers Sense of Self-Efficacy Scale was also used to compare differences in teacher's self-efficacy among the groups. Self-Efficacy is an influential factor relevant to teacher change and technology use. Consequently, there is a need to identify any differences for this construct across the groups, particularly because the sample size is such a low number. Monitoring this factor helped control for a confounding variable that may influence how teachers responded to the challenge. Before exploring differences in self-efficacy scores, descriptive statistics were applied to test for normality using SPSS version 26. As shown in the boxplot in Figure 4.6, there were no outliers discovered in the data, and the bell curve in Figure 4.7, showed equal distribution among the means.

Figure 4.6: Testing for Equal Distribution

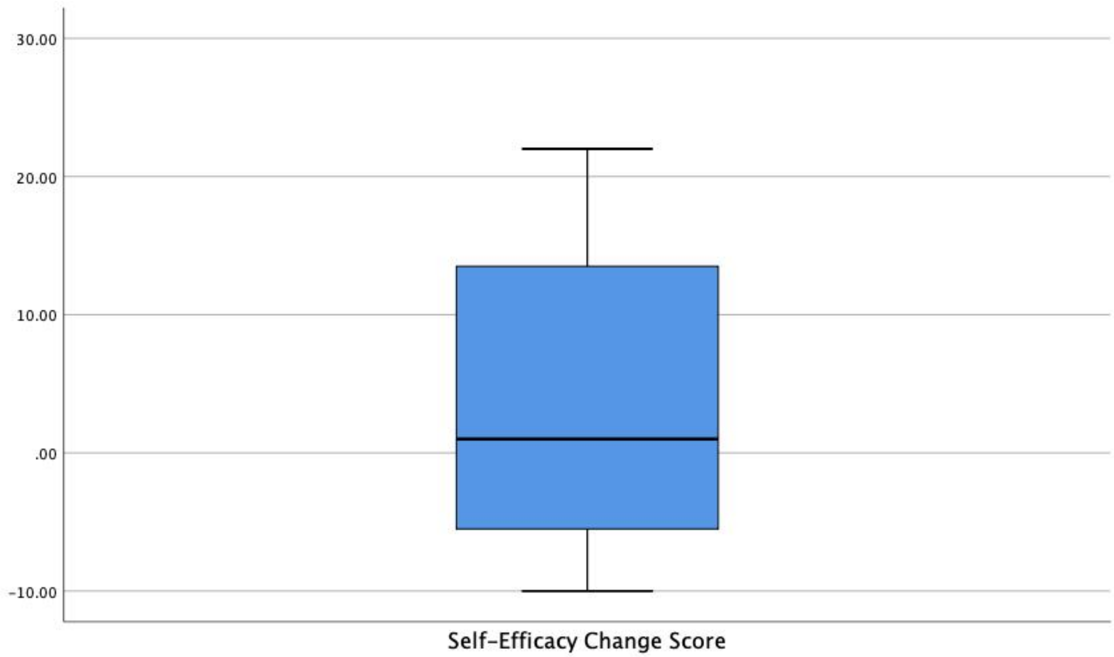

Figure 4.6: Descriptive statistics used to test for normality. This analysis showed no outliers within the data.

Figure 4.7: Testing for Outliers

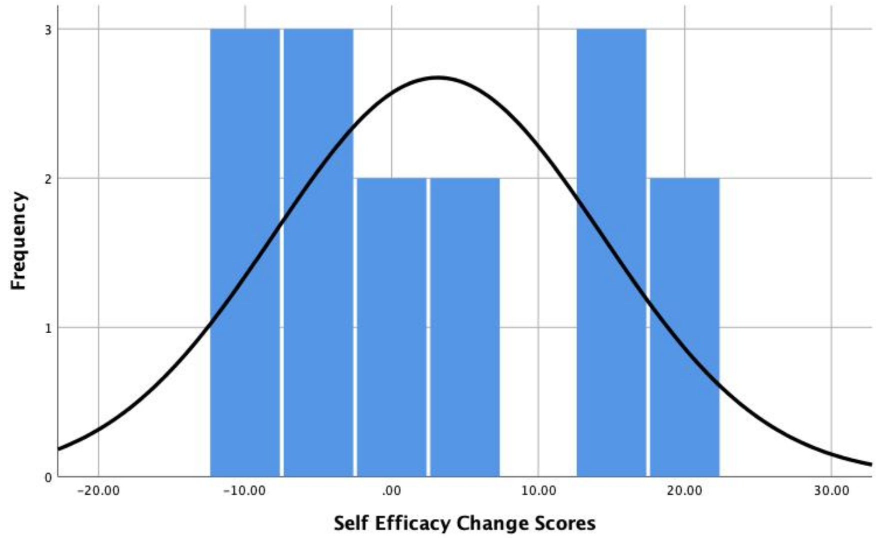

Figure 4.7: Descriptive statistics used to test for normality. This analysis showed equal distribution among the means

A single composite score was generated to combine total scores across the three subscales; strategy, engagement, and management. A total change score was then generated to compare changes in self-efficacy scores pre and post program. After confirming the absence of significant skewness or kurtosis within the data, a paired sample T-test checked for changes in self-efficacy scores pre and post-program (see Table 4.4), while an independent sample T-test checked for a difference among total change scores by group (see Table 4.5). No statistically significant differences were found in either of the tests. However, as the sample size was small the study also conducted a Mann Whitney test, which also suggested no statistically significant differences between the two groups (n=.081).

Table 4.4

Paired Samples T-Test for Self-Efficacy

	Mean	Std. Dev.	Sig. (2-tailed)
SE Pre-program	86.3	12.0	
SE Post-program	89.46	11.86	
	-3.13	11.19	.297

Note: Total SE scores compared for both groups pre/post program. Correlation is significant at p = <.05

Table 4.5

Independent Sample T-Test for Self-Efficacy

	N	Mean	Std. Dev.	Sig. (2-tailed)
Treatment	8	-1.87	8.64	
Comparison	7	8.85	11.55	
				.061

Note: Total SE change scores compared by treatment and comparison group. Correlation is significant at p = <.05

Second research question. A combination of quantitative and qualitative data addressed the second research. Deductive coding was initially used as a “start list” to guide an initial review of the qualitative data (Miles, Huberman, & Saldana, 2014, p. 81). As presented in Table 4.4, this start list included categories related to the teacher creativity questionnaire, which included constraints, evaluations, audience, and understanding of creativity. Predetermined codes were generated under each of these categories. Some modifications and additions took place to this initial list during the first and second cycle of data analysis. Making changes to these initial codes is considered acceptable under the conditions for deductive coding (Miles et al., 2014). Additions included creativity engagement, which formed a new category that emerged during the first review, while the category of students as an audience were added during a final inspection. The former captured the high volume of references toward student engagement when teachers were asked to define teacher creativity. At the same time, the latter became apparent during follow-up interviews, where participants expanded upon early interpretations presented in an initial summary document. Modifications to identified categories took place during the first and second cycles of coding. These modifications were a consequence of the first cycle, including in vivo coding, which contributed and expanded upon the initial list. For example, creativity new, became creativity novelty after in vivo coding revealed multiple phases associated with this term (i.e., different, alternative, inventive). There were also changes and additions. Responses on whether it's helpful to market creativity, focused more on the perception of an audience as opposed to the concept of marketing. Therefore, the category marketing was renamed as audience. Another prominent category to emerge was constraints. Although this category existed within the initial list, it focused on whether constraints were helpful or not helpful for teacher creativity. However, a review of the data revealed teachers overwhelmingly associated constraints with the curriculum and teaching evaluations. Consequently, these findings contributed to changes under this category, which have formed a significant aspect of the study's findings.

NVivo12 helped analyze qualitative data, which included the creation of memos to document ideas related to the perception of prominent categories and emerging themes during the process. After completing the second stage review, these memos helped form an initial summary document inspected by members of the treatment and comparison groups. These members then took part in a semi-structured interview to provide feedback on this document, while providing more insight into the themes that emerged from the data.

In-vivo coding evaluated some of the qualitative data from the self-assessment survey administered at the end of the program, which contributed to the categories represented in Table 4.6. A modification to the creativity rubric also helped conduct an internal audit of the reported outcomes (see Appendix J). This aspect of data analysis created a numerical value to compare the number of mini-c and little-c outcomes produced by each group. Finally, quantitative data from the SoC was merged into a comparison table with qualitative data from the teacher creativity questionnaire and the self-assessment survey. This table is included in the final chapter to explain the study's findings for the second research question.

Table 4.6

Codes for Analyzing Teacher Attitudes

Category/Code	In-Vivo Coding
Category: Creativity Understanding	
Novelty	Creativity is "original thinking" and "new and innovative ways" of doing things. Creativity is also about "being inventive", "putting your own spin" on something, or to be "different" or "think of alternatives"
Useful	Creativity is useful. It is something that can "produce a better end result". It is also about "enhancing learning" and adding "value" to the curriculum
Engagement	Creativity should "inspire students" and produce experiences that "reach a variety of types of student learners" "in ways that engage them" and "stimulating their curiosity about the world"
Growth	Creativity is professional growth. It's about "constantly improving practice through self-reflection and education."

Affordances	Creativity is having the capacity to identify and use affordances in the environment. It “is a teacher using whatever they need/have on hand” and “using all resources available”
Category: Constraints	
Constraints Negative	Constraints are perceived as having a negative impact. They “hinder creativity” and “the more constraints in the classroom the less creativity”
Constraints Positive	Constraints are perceived as having a positive impact on creativity. There were no references of positive constraints.
Constraints Vary	The impacts of constraints vary by context and depend on the person, “sometimes constraints lead to creativity” other times they lead to a “lack of creativity”. Regarding variation by context, perceived constraints of the curriculum “depends on the different departments”.
Constraints Rules	Constraints are “rules” that “constrain creativity” and “limit how much freedom teachers have to add to what they are doing”
Constraints Curriculum	“Classroom constraints that related to the curriculum limits our creativity.” Teachers expressed feeling “stressed when I deviate from a plan” and a “rigid curriculum stifles creativity”.
Category: Evaluations	
Evaluations Negative	Evaluations have a negative impact on teacher creativity because they “stifle creativity” and “can squish creativity.” Evaluations can make it “intimidating to try something new and try something you haven’t done before”
Evaluations Vary	The impact of teacher evaluations varies. Teacher evaluations “can allow teachers to find creative solutions to problems, but sometimes can stifle that creativity.” It “depends on the department you work for”
Evaluations Positive	Teacher evaluations can positively impact teacher creativity by pointing “out ways you do things, allowing for new ways to be let into the classroom.” “I look at evaluation as a place to grow as needed”

Category: Audience	
Audience-Self	When considering the importance of marketing creativity, some teachers expressed a self-view of creativity, “it is my classroom and I will do what works best for my students and me” and “I don't think it's necessary to get others to accept your creativity.” Other teachers expressed a belief that “what works for one may or may not work for another”
Audience-Students	When reflecting on creativity, students were seen as the main audience for the outcome. Teacher creativity is considered something to help “Grab” a student’s attention, which is “one of my number one goals for a teacher”
Audience-Administrators	When reflecting on creativity, administrators were seen as an influential audience that impacts teacher creativity. This perspective was expressed in attitudes toward teacher evaluations “If your idea of creativity does not match that of your evaluator, it does not go well for the teacher.”
Category: Techniques	
Techniques Help	Creativity techniques help fact-finding, which considers expanding perspectives, identifying relevant problems to address. “Creativity techniques can help the design process form a different perspective” and “understanding what a specific problem is also needs to be provided so that people aren't the blind leading the blind.”
Category: Development	
Creativity Increases	Creativity can increase, because “Creativity itself is not an innate” skill. Things like the “environment”, “having an open-mind”, and “exposure to new things” can help increase creativity. However, some teachers felt increasing creativity depends on how much “time you want to put in” and “effort.”
Category: Failure	
Failure Positive	Failure has a positive impact on teacher creativity. It “can encourage people to better themselves and their practices” and “helps people grow”.

Failure Negative	Failure can have a negative impact on teacher creativity by making "people more afraid" and might lead to a temporary "loss of courage" or make "teachers give up."
Failure Vary	The impact of failure can vary. It can help creativity, "but failure related to a supervisor stifles creativity" and "if reflected upon, failure might be helpful, but it can also be soul killing."
Category: Change in Practice	
Value Belief-Teacher Creativity Helps	A change of practice benefits from teacher creativity because "it can bring life and fun into the classroom." And because "new content or new strategies may not always go as planned."
Value Belief-Teacher Creativity Doesn't Help	A change in practice is not connected to teacher creativity, as "often things are thrust upon teachers without a thought as far as creativity."
Category: Group Creativity	
Groups Effective	Groups are more creative then individuals, as teacher's benefit from exchanging ideas "I think they are more creative when working together, because people can expand on each other ideas" and "The more minds the more ideas"
Individuals Effective	Individuals are more creative than groups "individuals, usually, unless the group is attuned toward project-making"
Group/Individual Vary	The value for working as an individual or in a group varies by project or person. "It depends on the dynamic of the group or the person"
Category: Generalize	
Domain General	Expressions of domain general perspectives of creativity "creativity is universal - it can be applied in many ways by the same person" and "People are always creative in many different areas"
Domain Specific	Expressions of domain specific perspective of creativity "generalized to specific content areas" and "I am creative

	in my job but do not consider myself creative in other areas"
Category: Outcomes	
Technology Focused	Explanation of outcome focused on expanded use of technology; " I doubt I would have dabbled with google sites prior to this project" and the challenge "had me look at the technology in a different way, that actually helped expand our usage of the website" and "the use of iMovie and garage band has been beneficial in other classes"
Problem Focused	Explanation of outcome focused on addressing a problem of practice; "it was a different and more worthwhile way to assess students […] the Claim/Evidence format helps students connect to the unit driving questions" and "it was new and useful because it was a more effective way to give timely feedback" and "checking for understanding of students before class started and directing instructional focus on certain questions students may have"
Engagement Focused	Explanation of outcome focused on increased student engagement or included references of success based on increased student engagement "this add-on allows interaction on a whole class level. Not only will students be engaged on a new level." Engagement also considered increasing active learning by being more "student-led" and creating "culminating projects"
Implementation Focused	Explanation of outcome focused on implementation. For example, one participant did not consider their outcome creative "Due to the fact that the plan as designed was not able to be implemented"

Note: Includes a selection of qualitative data from creativity questionnaire and self-assessment survey. Codes were revised after two cycles of data analysis, followed by feedback from individual participants of the study. Deductive coding focused analysis toward the research questions under investigation and attitudes toward teacher creativity.

Process evaluation. Data to conduct the process evaluation consisted of short surveys administered at the end of each workshop. One-legged interviews also contributed data to monitor progress during implementation (see Hall & Hord, 2015 for more information on one-legged interviews). This technique contributed to an intervention half-way through the study, while also helping identify teachers who were progressing successfully during the challenge. However, these short interviews were not approved for the research and did not contribute formal data to the investigation.

A chi-square test was used to analyze quantitative data from the workshop surveys, which addressed the question of how teachers experienced the program. This helped identify workshops where teachers reported a valued learning experience while also helping to determine the overall quality of delivery. Open-ended questions included on the workshop surveys helped monitor changes in attitudes and adherence during the C2032 challenge. This qualitative data was evaluated using in vivo coding and resulted in the categories displayed in Table 4.7. Participants of the program reviewed initial interpretations of this data as part of the interviews. Together, this information addressed the process evaluation questions.

Table 4.7

Codes for Process Evaluation

Category	**In-Vivo Coding**
Group Work	Captured expressed feelings toward working with colleagues during workshops “Since the beginning, speaking with colleagues has been the most helpful with clarification and brainstorming ideas”
Lack of Direction	Captured expressed feelings toward the direction offered within workshops, “I would not say though that there has really been any ‘instruction’ in any of the ‘workshop’ sessions.” Lack of direction also captured feelings toward a preconceived expectation of technology focused workshops, “this workshop did not inform or teach me anything new (i.e.; new google apps)".

Time to Explore	Expressed interests and preferences for technology focused activities. This includes satisfaction for the opportunity to go “through a bunch of Google apps.” and “take a look at various Google apps that I have had little to no experience with using” but also needs for greater time to explore technology “I would really like to get more time to share out different types of technologies people are using and have some time to get a quick tutorial”
Ambiguity	Expressed concerns toward the objective of the challenge, and its ambiguity to participants. “It was a bit vague to understand the goal of this challenge.” and “The end results were unclear as to the purpose for learning” and “I'm just still a little confused as to what we are actually going to be doing with students” and “not sure where it's going exactly.
External Challenges	Expressed challenges during the challenge, which included “My technology has not been approved for individual student use at this time.” and becoming distracted by other colleagues during workshops “There are other people that are checked out. It is hard to work in with mean people” and “It is annoying to be in a room with people who do not want to do this.” And after some teacher’s implemented their app, there felt they had nothing more to do in the workshops “I implemented my apps so I had very little to do”
Study Concerns	Expressed concerns toward the study, including the study’s objectives. “Without a true sense of the expectations of the study it's difficult to understand what I will be doing in order to satisfy the requirements.” and “I don't like being told to do something when I don't understand the data that's being collected” and “It was confusing what the data is actually meant to show. How is it being measured” and “"The pre-survey was challenging to comprehend and did not feel like all the questions necessarily matched the study."
Value Beliefs	Expressed concerns toward value of program and perceived relationship to teacher’s practice “I do not believe most of the things discussed apply to my teaching” and “not being able to completely apply this in my line of work here” and “I think creativity is an interesting topic, but not sure how it applies to my direct

	instruction and overall student growth." Value beliefs also captured an expression of other priorities "I have a LOT of work to do. This is just another item in my long list of things I don't have time to do."

Note: Combined qualitative data from workshop surveys and the process evaluation survey. Main categories were identified to address process evaluation questions and updated again after program-interviews. Categories contributed to overall themes identified from the study.

Conclusion

In this chapter, we presented a mixed-methods quasi-experimental research design used to investigate an intervention developed to support teacher creativity using new technology. The intervention took place over five months, consisting of six workshops. Data was primarily collected using a pre-and post-survey, a self-assessment survey, and a collection of short surveys administered at the end of each workshop. Attempts were made to address internal validity concerns, particularly regarding the impact of implementing the program when participants of the comparison group and treatment group are at the same school. Significant limitations exist in controlling for contamination across the different groups and implementing the challenge within a predetermined professional development schedule. Applying a concurrent mixed methods approach to this investigation, quantitative and qualitative data was collected simultaneously and evaluated separately after the program ended. Member checking of quantitative data took place through interviews with participants of the treatment and comparison group. The final chapter presents the results and conclusions of this study.

Chapter 5: Findings and Discussion

The previous chapter introduced a quasi-experimental mixed-methods study to investigate the impact of an intervention designed to promote teacher creativity when tasked with using new technology introduced as a consequence of an authority innovation-decision. The intervention contained four actions identified from common methods found in creative problem-solving and design thinking. Serving as the treatment, the study investigated whether this approach would support improvements to the learning experience as a consequence of new technology. The study was conducted at an inner-city middle school in Connecticut and involved eight participants assigned to a treatment group and seven participants to a comparison group. As a consequence of the challenges experienced during implementation, the first section of this chapter explores the following process evaluation questions, as they significantly contributed to the overall findings of this dissertation study:

> RQ3: How does the experience of the C2032 program vary among the comparison and treatment groups?
>
> RQ4: How do attitudes about the C2032 program change during implementation?
>
> RQ5: To what extent are members of the treatment group engaged in the four actions for teacher creativity?

Program Implementation

The C2032 program intended to promote four actions for teacher creativity. To accomplish this, teachers were challenged to produce a creative outcome using a new application associated with the G-suite. Members of the treatment group participated in four workshops that explored these actions, while teachers in the comparison group engaged in collaborative discussion in response to presented examples of technology products relevant to the challenge. The overall format of the workshops remained similar throughout; the first 10 minutes began with a presentation to introduce a concept or activity, followed by a 45-minute exercise to facilitate discussion among colleagues. All participants in the C2032 program received the same information about the challenge, which took place in the school's library before the workshops began.

Information about the program and corresponding study was emailed to teachers before the start of the academic year. The email included the objective to promote teacher creativity using applications associated with the G-suite platform and provided context to the study. An in-person presentation followed this initial communication during a full-faculty meeting in September. At this presentation, participants were given an overview of the program and made aware of an upcoming invitation to participate in a corresponding study. A month later, the first formal session of the C2032 program took place at the end of a full-day professional development event. This session included an introductory session that introduced the C2032 challenge, challenge rubric, and information about the study. After this orientation, participants were organized into their respective experimental groups and taken to different classrooms. Teachers were then invited to complete the pre-program questionnaire before starting the first workshop. What follows is a summary of the implementation of these workshops, including information about a self-assessment activity that was conducted as part of the conclusion to the C2032 program.

Workshop 1: Choose Destination

Participants in the treatment group received a short presentation about the four actions of teacher creativity, focusing on the concept of Choose Destination. Working in small groups, they then generated a list of problems they experience within their practice. As time was short, groups were organized based on sitting locations within the classroom. After this, participants then grouped problems by those commonly encountered by all teachers and those specific to domains.

The intension for participants in the alternative workshop was to experience a similar exercise. Participants in this group received a summary of potential apps for the challenge as opposed to receiving information about the four actions for teacher creativity. Teachers then engaged in small group exercises to explore some of these apps among colleagues. However, it's important to highlight that some members of this group shared frustrations toward the program during this session. This conversation expanded into a discussion about the organization of professional development within the school and district. As a consequence, the lead researcher adjusted plans for the second workshop to accommodate these concerns. These frustrations appeared evident in the workshop surveys collected after this first workshop and therefore contribute to the overall findings from the process evaluation.

Workshop 2: Chart Course

During the second workshop, teachers in the treatment group received an introduction to problem-statements, which were presented as a technique to reduce ambiguity by identifying an outcome and preferred method for execution. As part of this introduction, teachers were provided with a template and given examples of potential problem-statements relevant to the C2032 challenge. For instance, how might I use [insert technology] to [insert goal] in my [insert lesson or activity]? Teachers then used the remaining session to consider the goal and context they wanted to address for their problem-statement. The production of a problem-statement served as an outcome for the two stages of the intervention, choose destination and chart course. As part of this activity, teachers also received the same list of applications shared with the comparison group participants during the previous day. At the end of the workshops, teachers were asked to keep refining their problem-statements and begin exploring ideas to address this problem.

Teachers in the comparison group received an alternative clarification exercise. As opposed to problem-statements, participants received three vignettes that illustrated mini-c, little-c, and pro-c creativity examples. In small groups, these teachers then discussed each example and identified their level of creativity using the challenge rubric.
This activity's development took place as a consequence of questions raised about the rubric and ambiguity of the challenge during the previous workshop.

Workshop 3: Course Correct

As a consequence of a scheduling conflict, this workshop took place almost six weeks after the second workshop, and within a shortened time slot than initially planned. Furthermore, a proposed two-hour block of free time for teachers to work on the challenge did not take place for similar reasons. After informal meetings with individual teachers, it was determined that the extended gap between workshops had created a need to revisit introductory information about the challenge. This intervention took the form of a short presentation to teachers in both groups at the start of the third workshop session. This decision created a further reduction in time initially planned for this session.

It is also critical to highlight an incident of likely contamination during this presentation; a short conversation led to a specific reference toward the identification of problems of practice. This conversation appeared to resonate with some members of the comparison group, and after debriefing with the workshop facilitator, it seemed this conversation continued during the workshop. Although this conversation did not align precisely with the concepts of choose destination and chart course, it did potentially focus teachers' attention toward problems of practice and less on the technology.

During the workshops, members of the treatment group explored the central focus of the stage, correct course, which is experimentation, and the concept of learning through failure. The intent of this workshop was to connect discussions about failure toward the C2032 challenge, and experimentation of new technology. However, as a consequence of a shortened workshop session, these conversations never expanded beyond a general conversation toward this concept. As explored later, this outcome had a negative impact on adherence to the program.

Members of the comparison group also experienced a shortened workshop, nevertheless, the facilitator felt teachers responded well to the intervention and engaged in a more in-depth discussion than previously observed. Within the discussions, teachers shared examples of technology use in the classroom, with some reported references to how the technology addressed problems in the classroom. However, some members of the comparison group used discussion time to work on projects. As presented within the next section, this use of time was valued by teachers actively engaged in the challenge.

Workshop 4: Reflect

In the final workshop, teachers in the treatment group were asked to reflect on their methods for evaluating actions taken to address problems of practice. To introduce this concept, participants were introduced to internal and external feedback looks. An internal feedback loop was presented as limiting evaluation of actions and observed outcomes to the individual's perspective only, while external feedback loops were introduced as soliciting additional feedback from students, colleagues, and administrators. Teachers were tasked to reflect on the extent to which they actively seek external feedback from within their environment. This conversation included requests for examples, while also challenging some to consider whether they have sufficient information to evaluate outcomes when not securing outside perspectives.

Members of the comparison group were encouraged to participate in a similar reflective exercise, only it was less focused on discussion of the process, and more toward feedback on ideas for the C2032 challenge. Teachers in this group were invited to present working ideas in response to the challenge. In return, other colleagues were invited to provide feedback using the challenge rubric. Conversations therefore centered on whether the idea was new and useful within the context of the teacher's learning environment.

Self-Assessment Activity

As part of a process to promote teacher creativity, an evaluation of outcomes produced from the C2032 challenge was needed to determine the level of creativity when comparing the two groups, as well as the overall success of the program. As discussed in the previous chapter, evaluation of outcomes was guided by the development of a challenge rubric that integrated the 4-C model of creativity. This rubric measured the level of creativity by framing outcomes as either mini-c, little-c, or pro-c creativity. The intent was to conduct an evaluation of outcomes by an external group of professionals with knowledge of the community. However, early interactions at the school suggested this component of the program may be viewed negatively by participants. After the first workshop, this view was confirmed after some members expressed strong concerns toward the use of a rubric that was perceived as casting judgement on ideas for using new technology. The findings from the process evaluation provide some insight into potential causes of these concerns, which include varying views of what constitutes as teacher creativity, the influence of environmental factors such as teacher evaluations, and a feeling that creativity is something best evaluated by the individual. There were also other concerns expressed that were unrelated to the program, but nevertheless constituted as challenges during implementation. Consequently, this aspect of the program was changed to using peer-assessments as a way to evaluate outcomes, which were then used to inform a final self-assessment gathered for the purpose of the study.

Challenges to self-assessment. Changes to the program schedule created a large gap between the first two workshops, and the final two workshops. Interaction with the community suggested that some members of the program had not worked much on the C2032 challenge. Consequently, after the final workshop, teachers in both experimental groups requested extra time to work on their idea before participating in a formal assessment to end the program. This request was considered a positive development, as it suggested renewed interest in the C2032 challenge; however, it also created more scheduling problems. The next session was a two-hour work block dedicated to the peer and self-assessment activity, as well as a block of time where the post-program survey was to be administered. Therefore, accommodating the request for free time impacted the self-assessment activity, which was subsequently redesigned to accommodate a new 50-minute working session. Furthermore, the post-program survey was administered at the end of this two-hour working session, as opposed to taking place at the end of the program. This meant that the stages of concern questionnaire captured teacher concerns toward the C2032 challenge, before some teachers had completed the program.

Implementation of self-assessment. To address the shortened time to evaluate outcomes, teachers were quickly placed in small groups. Acknowledging the need for participants to have knowledge of the context to where the outcome was implemented, these groups were organized by subject, which led to some mixing of treatment group and comparison group members. To address the shortened time frame for this activity, a Google doc was created to guide the peer-assessments that took place within these groups (see Appendix K). The Google doc was copied and then shared among groups members, which allowed individuals to make notes while receiving feedback from their colleagues. These notes then helped teachers quickly complete the self-assessment survey, which was administered at the end of this session.

Despite the challenges experienced conducting an evaluation of outcomes produced from the C2032 challenge, data from the self-assessment survey did provide insight toward the artifacts produced in the program. As shown in Table 5.1, the majority of the artifacts used an application from the G-suite as their new technology. However, there were slightly more uses of G-suite applications among members of the treatment group (n=10), while members of the comparison group appeared to have slightly more occurrences of technology beyond Google (n=13). Technology that was perceived as having a potential to increase student engagement appeared popular, particularly among members of the comparison group. These applications included Peer-Deck, Google Tour Builder, Kahoot, iMove, and Garageband. Other technology that proved popular was applications that captured student data in support of formative assessment, and those that improved the distribution of information.

There was also a lack of detail in some of the survey responses, which made it difficult to distinguish between ideas that were enacted, versus ideas that were still in development, but it did appear that not everyone had implemented their ideas. There was also an indication that some ideas may have been enacted outside the challenge, with one member of the comparison group stating, “I would already do this without the C2032 challenge.” Data gathered from this instrument included teachers who had not participated in the pre and post-program survey, but as a consequence of an error in the survey design, it wasn’t possible to distinguish between these two different groups. Therefore, although every respondent to the survey reported an idea in response to the C2032 challenge (n=35), it is not clear how many ideas were a direct result of actual participation. This outcome is disappointing, as other data gathered from the pre/post-program surveys and follow-up interviews does suggest ideas produced as a result of the program. However, without having the capacity to identify these ideas within the self-assessment survey, data gathered from this instrument is primarily limited to the process evaluation.

Table 5.1

Technology used to produce C2032 artifact

	Existing Tech		New Tech	Google Product
Treatment				
	Classroom	5	Google Keep	Yes
	Jeopardy	1	Google Forms	Yes
	Pencil/Paper	2	Quizizz	No
	Google docs		Kahoot	No
	Google forms		ASSESments	No
	Google Keep		Google Sites	Yes
	Google Slides		Google Translate	Yes
	Google Sheets		PeerDeck	No
	Laptop		IXL 1	No
			Classroom	Yes
Comparison				
	YouTube		Soundtrap	No
	Classroom		Classroom	Yes
	Google Sheets		Quizlet	No
	Google Sites		PearDeck	Yes
	PearDeck		Google forms	Yes
	EdPuzzle		Screencastify	No
	IEP Direct		Plickers	No
	Google Slides		Google sheets	Yes
	Google Forms		Google Tour Builder	Yes
	Gmail		iMovie	No
	Chrome		Beta Plagiarism Checker	No
	Soundtraps 1		Kahoot	No
			Google sites	Yes
			Google forms	Yes
			Google docs	Yes
			Garageband	Yes
			Google translate	Yes
			EdPuzzle	Yes

Note: New and existing applications used in response to the C2032 challenge

Process Evaluation

Research Question 3

The first process evaluation question addressed how experiences of the C2032 program varied among the comparison and treatment groups. This question was considered critical as experimental groups were led by two different workshop facilitators. Consequently, monitoring the quality of instruction not only addressed program fidelity, but also helped to accommodate a confounding variable caused as a consequence of this situation. A chi-square test was used to compare members of each group and how they ranked the instructor's success in facilitating the understanding of workshop material, and also their reported learning of the material. The success was ranked using a 5-point Likert scale, which ranged from extremely well, very well, moderately well, slightly well, and not well at all (see Table 5.2). While reported learning of material was also ranked using a 5-point Likert scale, but ranged from a great deal, a lot, a moderate amount, a little, and nothing at all (Table 5.3).

Table 5.2

Chi-Square to Compare Quality of Instruction

	Extr. Well	Very Well	Mod. Well	Slightly Well	Not well	Phi Value	Asymp. (2-sided)
Workshop 1							
Treatment	3	9	6	3	0	.263	.563
Comparison	1	7	9	4	1		
Workshop 2							
Treatment	12	6	4	1	0	.265	.329
Comparison	7	11	7	1	0		
Workshop 3							
Treatment	5	5	5	1	0	.327	.247
Comparison	2	12	6	3	0		
Workshop 4							
Treatment	1	5	4	4	4	.216	.804
Comparison	2	4	6	2	3		

Note: Total SE scores compared for both groups pre/post program. Correlation is significant at p = <.05

Table 5.3

Chi-Square to Compare Learning of Material

	Great Deal	A Lot	Mod. Amount	A Little	Nothing At All	Phi Value	Asymp. (2-sided)
Workshop 1							
Treatment	2	3	8	8	1	.287	.461
Comparison	1	1	9	10	2		
Workshop 2							
Treatment	2	7	7	4	3	.314	.307
Comparison	1	8	9	8	0		
Workshop 3							
Treatment	2	3	6	3	3	.182	.856
Comparison	2	3	10	6	2		
Workshop 4							
Treatment	1	1	8	7	3	.262	.637
Comparison	0	3	5	6	3		

Note: Total SE scores compared for both groups pre/post program. Correlation is significant at $p = <.05$

Data analysis suggest no statistically significant difference in the quality of instruction or reported learning of material by members of the treatment group and comparison group. With small to medium effect sizes reported. However, there was a noted decrease in satisfaction toward teaching during the final workshop, and this followed a general decrease in reported learning of material as the program progressed. This dissatisfaction seemed apparent in both groups, which may be a result of teachers increasingly becoming frustrated with a lack of guidance toward the challenge or an impact of weaker adherence. Either of these views is supported by an increase in satisfaction toward the quality of instruction during the second workshop. As discussed in the previous section, the second workshop produced outcomes that helped clarify the challenge and included the presentation of explicit examples. As reported in the next section, the lack of guidance and an expectation of technology focused professional development might further explain these results. Nevertheless, the findings of this analysis do not indicate a significant difference in how participants of the C2032 program perceived the quality of instruction. Furthermore, participants reported some learning of the material and general satisfaction toward the facilitation of workshops. Therefore, evidence does not indicate a significant difference in how teachers perceived the quality of instruction between the two workshops

Research Question 4

The next process evaluation question captured qualitative data to monitor attitudes toward C2032 program. Figure 5.1. presents the main categories expressed within the qualitative data collected from the workshop surveys. These include group work, clarification, ambiguity, study concerns, value beliefs, and growing requests for time to explore.

Figure 5.1: Themes

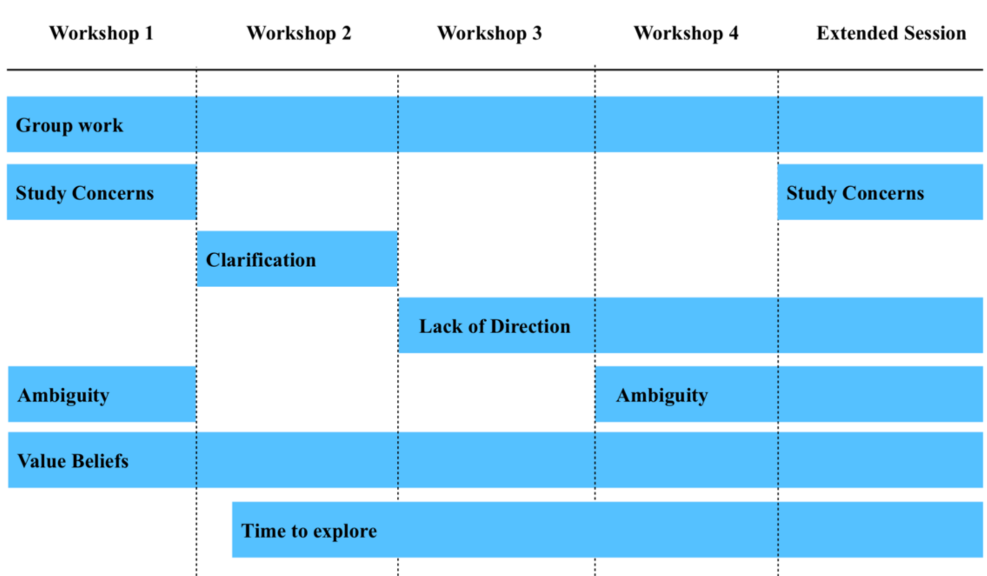

Figure 5.1. Presents prominent themes during the program's implementation, where were referenced by at least two people on post workshop surveys. Themes were reviewed and confirmed during post-program interviews.

Working with colleagues. Teachers in both groups expressed positive attitudes toward the collaborative approach taken during workshops. These positive attitudes included comments such as "I liked the ability to share ideas with many different colleagues" and "I enjoyed the time to collaborate and reflect with my colleagues." Likewise, when presenting this interpretation during an interview with a member of the comparison group, that individual followed up by stating:

> we don't get a change to do that very often, without some sort of structure imposed on it, or some constraints put on hand, and we don't get a chance to collaborate with colleagues from other disciplines.

Positive attitudes toward the opportunity to work with colleagues was also expressed by members of the treatment group and remained constant throughout the program.

> I appreciated having the opportunity to have multiple discussions with colleagues about my idea as well as my own. I enjoyed having the chance to hear where my colleagues are at with their own ideas and how they plan on utilizing them going forward.

Study concerns. Information about the corresponding study was communicated to teachers in an email and during a presentation that took place before the start of the program. This Information was revisited again during the orientation session that took place before the first workshop. During these communications, teachers were informed that C2032 is part of the professional development program for the 2019/2020 academic year, while requests for data (e.g., surveys) formed part of the corresponding study into teacher creativity and were completely voluntary. Nevertheless, concerns about the study were expressed in surveys after the first workshop, they included comments such as “the pre-survey was challenging to comprehend and did not feel like all the questions necessarily matched the study” and “it was confusing what the data is actually meant to show. How is it being measured.” These comments were mostly expressed by members of the comparison group and appear to represent the concerns observed during the first workshop. Although they suggest concerns toward the study, they may also represent concerns toward overall participation in the program. Examples of these statements include, “without a true sense of the expectations of the study it's difficult to understand what I will be doing in order to satisfy the requirements.” When discussing this situation during the post program interviews, one of the teachers remarked “teachers like to do things right, if they don’t know what or why they’re doing it, it is very uncomfortable.” Therefore, it is possible teachers lacked sufficient information about the end goals of the program, which might be attributed to the timing of the initial orientation and workshop. Not only was the introduction of the program at the end of the long professional development day, but it took place nearing the end of October, which might be when participants are beginning to feel time constraints of the semester. Although not specifically addressing this point, during an interview one participant remarked that the timing of the study might have impacted some responses from participants, because as the semester progresses “teachers get more pissed off as people ask them to do more things.” Alternatively, concerns toward the study might be attributed to negative feelings toward the use of data within the community (e.g., school or district). This perspective was something observed during the initial workshop and supported by a statement made by a participate of the post-program interviews “the word data is a trigger word for me.”

The majority of concerns about the study were expressed after the first workshop and were mentioned less as workshops progressed, though they did resurface for some toward the end of the program. Nevertheless, the observed reduction after the first workshop might be a result of teachers understanding differences between the study and the program. However, there is also indication that activities in the second workshop helped address some of these concerns thanks to the presentation of problem-statements in the treatment group, and specific examples shared within the comparison group. This view is supported by noted remarks such as, “I enjoyed that my small group was able to apply the rubric to a tool a colleague created. The stories were helpful to put the c's into perspective” and “clarification, facilitator adapting the content to address some key problems.” The concept of greater clarification was a statement shared by other members as well:

> Clarification on the rubric and examples were provided. Discussions with peers were helpful to see how other people interpret things. I was observing others interactions and seemed to think that there was a change in outlook, more positive than the previous session.

In the treatment group there were also positive references toward greater clarity as a consequence of the presentation of problem-statements, which provided focus toward the challenge “working to create a problem statement with the technology support as the focus” and “I liked how we focused more about problem statements. This got me thinking about what my own problem statement might be and how I can use tech to address it.” Although concerns toward the program remained, there were significantly less references toward the study after the second workshop (n=1).

Lack of direction. As workshops progressed there were references to a lack of direction, which was expressed by members of the comparison group. For example, after workshop three, two teachers stated “not enough direction” in response to the question, what did you like least about this workshop. Another teacher stated “there [hasn’t] really been any instruction in any of the workshop sessions” after the final workshop.

Other teachers indicated that discussions among colleagues provided some direction, for example, a teacher in the treatment group stated “speaking with colleagues has been the most helpful with clarification and brainstorming ideas”, while a teacher in the comparison group shared a similar perspective “I also was happy that another teacher asked me how to implement something similar for his subject area.”. There were also other references that could be interpreted toward a lack of direction, but equally attributed to the ambiguity of the challenge, which was described by one participant as “a bit vague”.

Ambiguity. Concerns toward unclear objectives and unknown outcomes followed initial concerns toward the study and remained constant for some members as the program progressed. These comments ranged from questions on how the C2032 program related to students “I'm just still a little confused as to what we are actually going to be doing with students” to the program’s deliverables “I'm not sure I fully understand the purpose or where we're headed and by when.” These concerns were expressed throughout the program, and the vagueness of the challenge was mentioned as being “a frustration with a lot of people” by a participant of the post-program interviews.

Value beliefs. Connecting the program to existing value beliefs was another prominent theme to emerge during the workshops. As referenced in the previous section, some teachers were unable to see the value of the program from the perspective of its impact on students, while others did not consider their role as being relevant to teacher creativity; for example after the first workshop two participants responded in the survey by saying, “I do not believe most of the things discussed apply to my teaching” and “I think creativity is an interesting topic, but not sure how it applies to my direct instruction and overall student growth.” There were also indications that teachers were concerned with other higher priorities “the initiatives of this study are not aligned to my own learning goals this year. I do not feel that this is a good use of my time” and “I feel that there are other topics that are a higher priority.”

During the first workshop other teachers expressed value beliefs associated with their existing understanding of the technology “I feel like I have a lot of experience with the G Suite apps. So the information was a bit redundant for me personally” and “many of the apps listed as options are things I already use or am familiar with.” These perspectives suggest that teachers with high self-efficacy toward Google products, might also have struggled to connect the value of the C2032 program to their existing practice. This is a perspective already recognized within the existing literature within the concept of establishing a sense of dissidence toward an existing practice (see Anderson, 2017).

However, this perspective might be different for teachers who consider themselves less familiar with Google products, for example “I feel that finding new apps and new information online will only help students succeed” and “I like that other teachers who may need development in technology had the opportunity to learn something." This latter statement signifies a potential divide in how teachers connected the C2032 program to their existing value beliefs. For those comfortable with technology, the C2032 program might not be something they valued, as they already consider themselves creative with the technology. Whereas for others, the challenge provided the opportunity to explore new applications associated with the G-suite. This view explains some of the positive feedback expressed toward the initial overview of Google applications "I most enjoyed the opportunity to take a look at various Google apps that I have had little to no experience with using. There are several apps I would like to find used for in my classroom."

Time. Statements from the workshop surveys suggest that those who were engaged in the challenge valued the opportunity to explore new technology. As a consequence, it is possible that these teachers expected more tutorials in support of technology use, as well as greater time to explore different applications. There is some indication that this expectation was met for members of the comparison group, while for members of the treatment group, instruction toward the technology never materialized:

> I would really like to get more time to share out different types of technologies people are using and have some time to get a quick tutorial, or at least more detail, in how they are using these systems in their classrooms so I can consider using them in my classroom.

These comments occurred more among members of the treatment group, who began to express a desire for more time to work on their challenge as the program progressed, and frustration when that opportunity never materialized "we should have been given time to brainstorm solutions to that problem, and additional time to create a solution to that problem."

Although, some members of the comparison group expressed similar desires for more time, others valued the opportunity to work on their projects during discussions with colleagues "I liked working with my colleagues on improving our practice. I liked having an excuse to try new things." Furthermore, as referenced earlier in the chapter, some of these discussions provided an opportunity to work on projects. This use of time was positively received by those who were actively engaged in the challenge, "I was finally able to put together what I'm going to use for this challenge." Therefore, attitudes toward time were expressed differently by some members of the treatment and comparison group. When raising this interpretation during post-program interviews, a member of the comparison group said "I looked at it as an opportunity to do something that I had wanted to do and have time allotted to do it and possibly get some support in learning the application", while a member of the treatment group felt that the workshops "went on with nothing happening". Interestingly, another member of the treatment group suggested that expectations of the program may have come about as a consequence of previous professional development experiences that provide teachers with "very specific lessons or tasks." In this interview the teacher acknowledged that the program was "never promoted to us as that, I think that was just our assumptions." Consequently, preconceived views of the program, including a perceived focus toward technology training, may have contributed to varying expectations among participants.

Summary

The process evaluation revealed that teachers in the program valued the opportunity to collaborate with colleagues, and those possibly less familiar with technology appreciated the chance to explore applications associated with the G-suite. However, other teachers were unable to see the value of the C2032 program, and how it related to the classroom and their students. Frustrations toward the program and corresponding study were also evident, particularly after the initial workshop. As referenced in the implementation summary, it's possible this frustration was not a result of the C2032 program, but previous experience of professional development. Nevertheless, it appeared to impact initial responses to the program, which may have developed resistance that impacted a willingness to engage in the challenge.

Finally, changes to the program's schedule impacted opportunities for teachers to work on projects. Originally, a two-hour block in November was organized for teachers to begin working on their challenge, but due to a scheduling conflict this time never materialized. This situation may have negatively impacted attitudes toward the C2032 program, with many requesting greater clarification toward the challenge, more guidance in workshops, and more opportunity to explore the technology.

Research Question 5

There were two process evaluation surveys generated to monitor whether teacher's in the treatment group were engaging in the four actions for teacher creativity. These surveys were similar to the workshop surveys, though administered halfway through the program via a schoolwide email, as well as before an additional program session organized to provide teachers with free time to work on projects. Only three respondents completed the first survey distributed via email, which included a second administration of the SoC questionnaire. Consequently, teacher concerns expressed toward the C2032 challenge were only captured at the beginning and end of the program. This limitation is discussed further in the discussion section that concludes this study.

The second process evaluation included questions that captured evidence of adherence to the program, which when combined with data obtained from the workshop surveys, indicated weak adherence to the four actions for teacher creativity. However, there are indications toward some adherence of the first and second actions associated with choose destination and chart course (see Table 5.4), which seemed to help at least one member engage in a reflective process toward the end of the program. As referenced during a post-program interview, problem-statements was perceived as "some of the most learning that we did" and helped "focus" teacher's attention toward a specific problem of practice. Likewise, as a consequence of an existing problem-statement, a teacher was able to determine that their intended use of a technology was not effective because it was unlikely to address the problem-statement they generated, and therefore looked toward a course correction. This process also included reflection on the problem-statement, and consequently some evidence of adherence to all four stages:

> in theory it seemed like a good tool. It has the potential to stop them and then have them answer questions throughout a lesson as a tool of reflection. However, upon reflection it seemed like a lot of leg work ahead of time and may not have gotten the job done as a reflection tool. Would students have been able to look back at their responses for the "reflection" purpose? Further steps: rather than an independent effort would it work better as group responses?

However, although some members of the treatment group produced a problem-statement, others found it difficult without adequate time to explore the technology "It was difficult to write a problem statement where we had to insert technology since we haven't really had time to preview the options" Other members identified problems, but had not completed the second action that leads to a formulated problem-statement "the number of students plagiarizing assignments is increasing". Nevertheless, data gathered from the process evaluation indicates some adherence toward the first two actions by all member of the treatment group, excluding one study member who did not report having a problem or problem-statement.

Table 5.4

Adherence to Treatment

Choose Destination Identify problems of practice	grading of assessments, plagiarism, disorganized students, recording student benchmark, increasing formative assessments, student engagement, students not connecting previous learning
Chart Course Submitted problem-statements	• How can I used Google Slides and Pear Deck to increase my number of formative assessments during the lesson in all of my history classes? • My problem statement is in order to improve learning outcomes in the classroom I will use pear deck with google slides to help students reflect on what they learned • How might I use Google Form to have students log questions/ problems that they may have about ELA homework? Value: This would allow me to more readily identify which commonalities to quickly address. • How am I going to use Google Forms to record student benchmark data? • How might I use Google Classroom that links to a Google document that links to specific IXL sections to practice? • How might I use YouTube to increase the interest of low performing students in my 8th grade class?

Note: Data interpreted from process evaluation surveys. Only the first two actions, Choose Destination and Chart Course adhered to the program during implementation.

Outcome Evaluation

The two outcome evaluation questions were designed to investigate differences between members of the treatment and comparison group. However, as explored within the process evaluation, events during the program's implementation impacted the capacity to adequately address these questions. Nevertheless, the first question considered whether the four actions of teacher creativity facilitated change using new technology, while the second question investigated whether these actions promoted teacher creativity:

RQ1: Do the four actions for teacher creativity support change using a new application associated with the G-suite?

RQ2: How does participation in C2032 influence teacher creativity when challenged to use new applications associated with the G-suite?

Although similar, these two outcomes are different; the CBAM framework used to measure the first question captures teacher concerns to investigate progress toward change as a consequence of participation in the C2032 program. While the second question considers this progress, but also attitudes toward teacher creativity and whether the outcomes produced constitute as mini-c, little-c, or pro-c creativity.

Research Question 1

As shown in Figure 5.2 and 5.3, participants in both groups expressed the greatest concern in the unrelated stage of the CBAM framework in the pre and post survey data. This suggests that the C2032 challenge was not a priority for participants at the beginning of the C2032 program, and there was little challenge toward these feelings as expressed in the post-survey. However, concerns for stages 1, 2, and 3, are also high for these groups. This indicates some level of intent to engage in the challenge but concerns for how participation will impact existing practices are prominent (Hall & Hord, 2015). Furthermore, Hall and Hord (2015), also propose that high self-concerns might indicate fears toward the challenge and the subsequent outcomes that emerge as a consequence of participation. This is because stage 1 concerns represent a desire for more information about the C2032 Challenge, and therefore might represent some of the varying value beliefs expressed during the process evaluation. Likewise, stage 2 concerns indicate a worry toward how implementation of the C2032 challenge will impact existing practices.

Figure 5.2: Pre/Post SoC for Treatment Group

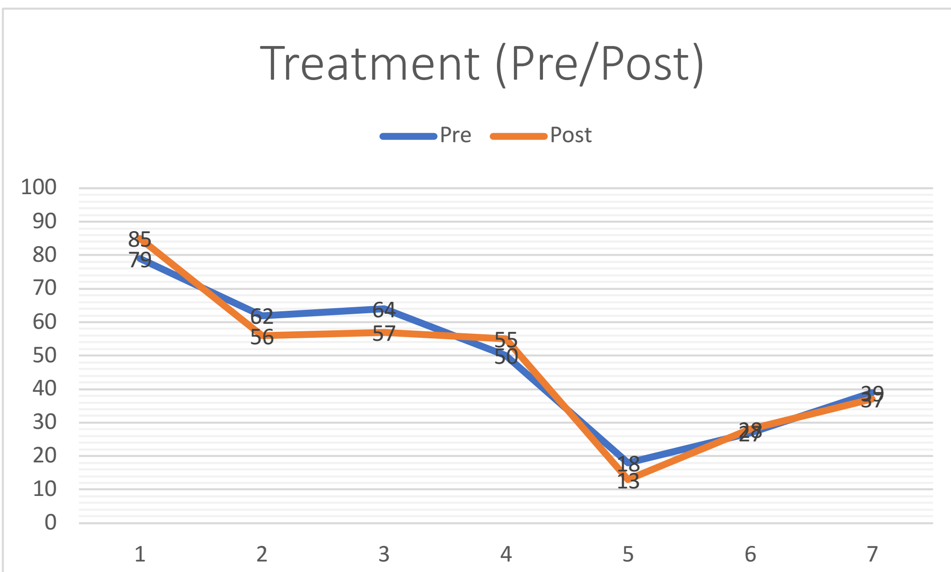

Figure 5.2. SoC profile for treatment group.

Figure 5.3: Pre/Post SoC for Comparison Group

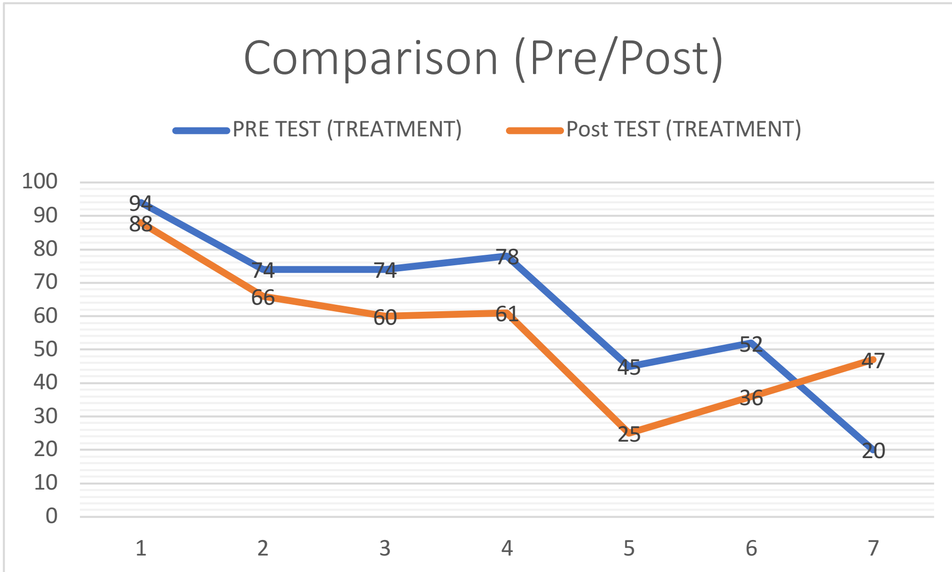

Figure 5.3. SoC profile for comparison group.

An explanation for consistent high concerns in stages 1 and 2 might be an outcome of the C2032 Challenge itself. The challenge to produce a creative outcome using a new technology focuses entirely on a teacher's individual practice, and not necessarily the immediate implementation of a proposed solution. This may also explain why both groups express low concerns for stages 4 and 5, which can represent a professional learning community where teachers are working collaboratively to implement the proposed change (Hall & Hord, 2015). As expressed during the process evaluations, many teachers were awaiting further instruction or free time to develop their ideas. Consequently, it's possible many participants never reached a stage where they were able to implement their idea in the classroom.

Stage 3 concerns were a little higher in the comparison group at the beginning of the program, and then became more aligned with the treatment group at the end. These represent the task cluster within the CBAM framework. Task concerns were present in both groups and are indicative of questions about management and the ability to produce a new and useful outcome under the conditions present during the program's implementation. Potential explanations for this concern reside in the qualitative data presented in the next section, which identified factors in the environment such as a rigid curriculum and teacher evaluations. However, within the process evaluations teachers also expressed worry about their ability to effectively participate in the C2032 Challenge while meeting their existing responsibilities at the school.

Although peaks across the CBAM stages appear reasonably stable, with no significant dips or rises across the two groups, there are noticeable changes in percentile scores for members of the comparison group, which are not present in the data that represent members of the treatment group. George et al. (2013) consider a 7-10-point change as being relevant, and for members of the comparison group, there is an 8-15-point dip across stages 1 through 5, and a 27-point increase for stage 6. The latter increase established what Hall and Hord (2015) refer to as a tailing up of CBAM concerns toward the C2032 challenge.

Stage 6 represents the refocusing stage, which is when an individual is curious about alternatives that might produce a better outcome (Hall & Hord, 2015). However, when combining this tailing up with peak scores in the unrelated stage, members of the comparison group are expressing a resistance toward the challenge (George et al., 2013), which was not present at the beginning of the program. This view is supported with declining SoC scores in stages 1 through 5, which show less concern toward implementation.

Conclusion

The first outcome evaluation question investigated whether the four actions of teacher creativity helped teachers when tasked with producing a new outcome using new technology. As a consequence of a small sample size and weak adherence to the latter stages of the program, it is not possible to address this question as we cannot infer that observed differences between the two experimental groups had anything to do with the application of the four actions for teacher creativity. Nevertheless, we can infer a difference in how teachers in the two experimental groups responded to the C2032 challenge. After three months of participating in the program, members of the treatment group are not resisting the challenge to produce a creative outcome using new technology, and simply remain at the point of needing more information and support. Whereas members of the comparison group moved toward concerns suggesting resistance toward the challenge, indicating they wanted to move on either as a consequence of feeling they had completed the task, or feeling that the task had little value to their practice.

Research Question 2

The second outcome evaluation question investigated how participation in the C2032 program influenced teacher creativity when using new applications associated with the G-suite. This question considered the overall experience toward the challenge, while also comparing observed changes between the experimental groups. However, as a consequence of weak adherence to the program, it is not possible to investigate the impact for all four actions for teacher creativity; however, there is evidence of adherence toward the first two actions, choose destination and chart course. Therefore, when investigating how participation in the C2032 program impacted teacher creativity, the review of findings is dedicated exclusively to these two items, as opposed to all four actions. Furthermore, as all participants received the same information toward the C2032 challenge, there is an opportunity to investigate factors relevant to participation in a challenge to produce a creative outcome using technology introduced as a consequence of an authority innovation-decision. The presentation of findings begins with an overview of constant themes shared among members of the experimental groups, followed by a section on observed differences. These sections then contribute to the overall conclusion of this study, which merges qualitative findings with the quantitative data collected from the SoC questionnaire.

Attitudes to Teacher Creativity

Creativity understanding. At the beginning of the program, the majority of teachers participating in the treatment group considered teacher creativity as something associated with the generation of original ideas and student engagement in the classroom. Specifically, teacher creativity was defined as “new and exciting ideas designed to engage a variety of learners” and “finding new ways to engage students.”. Other expressions of originality included “using different strategies and methods”, while alternative words that were perceived as engagement included “get students curious”, “effectively reach”, and “capture students’ minds.” When discussing this view during interviews a teacher stated, “student engagement is a key word that we hear a lot – and that’s one of my number one goals for a teacher, because if they’re not engaged, they’re not learning.” While another teacher discussed the constant need to “grab” learner’s attention as they have “ever changing” needs as a consequence of “what they are exposed to in the world.”

Understanding toward teacher creativity for members of the comparison group were similar regarding the concept of novelty. However, there was little more variety, and a somewhat more focused attitude toward the relationship with student outcomes. For example, "teaching students to think for themselves and problem solving in any content area" and "the ability to focus student ideas into some form of communication that is readable to relate to others". Finally, within attitudes toward teacher creativity expressed from members of the comparison group, there was a reference to producing something different than what's presented on the curriculum, "the ability to do whatever is necessary to engage all students in meaningful learning experiences that does not necessarily match methods in the current curriculum." This statement was interpreted as being relatable to the concept of "having the freedom to value add to lessons." When discussing this addition to the concept of teacher creativity, a member of the comparison group considered this interpretation as being "very accurate, based on conversations with other teachers." As presented in the following sections, the perception of a teacher's ability to change and modify the curriculum emerged as a recurring theme throughout this study.

Constraints. On the teacher creativity questionnaire, participants of the study were asked whether classroom constraints positively or negatively impact teacher creativity. Attitudes toward constraints were overwhelmingly perceived as having a negative impact on teacher creativity. These perceptions were shared amongst members of both groups, expressed through words such as "squish", "squash" and "limit". Specific references to classroom constraints referenced the curriculum, which is perceived as requiring teachers to "stay within certain boundaries when being creative." This perception was also interpreted as being connected to comments such as, "rules placed upon teachers by the administration." During an interview, a teacher supported this interpretation by stating "the curricular we have in our district and the rules that have been instated, imposed, really limit how much freedom teachers have to add to what they are doing."

The negative views expressed toward the curriculum as a constraint may vary depending on department. During the interviews, it was discovered that some subjects are more scripted than others; one teacher explained that within her department the curriculum is perceived as an outline that provides freedom to explore different ways to meet objectives, while other departments who have a more "canned" curriculum might not feel the same. This perspective was supported by another teacher who explained that the curriculum in her department is "very scripted", and although she's experienced a little more freedom recently, she hasn't "felt like a good teacher at all because of these constraints." Furthermore, the perceived constraints on her curriculum has made her feel powerless, as "there will be times when I see they're not engaged and there's nothing I can do about it." This feeling of disempowerment toward making changes in practice is a potential barrier to teacher creativity and may explain why some participants in this study considered the concept as either not meaningful to them, or simply being something that is added to a prescribed curriculum. This view may contribute to perspectives of teacher creativity being an "oxymoron" (Bramwell et al., 2011, p.229)

Teacher evaluations. Within the treatment group there was less agreement on how teacher evaluations impact teacher creativity. Some members felt they do not influence teacher creativity; others suggested teacher creativity is not the focus of teacher evaluations; while another said it "depends on the department you work for." There were also positive and negative views of teacher evaluations expressed; the positive view saw teacher evaluations as an opportunity to "point out ways you do things, allowing for new ways to be let into your classroom" while the negative view revisited the perceived influence of the curriculum "I have a scripted curriculum so unfortunately, evaluation do not help encourage me to be creative."

The negative attitudes toward teacher evaluations was more prominent from members in the comparison group, with five out of the seven teachers responding with statements like "teacher evaluations squash creativity in lesson planning" they are "stressful and limit creativity" and "reduce everything to box-checking." Furthermore, the ongoing pressure of evaluations might make teacher's reluctant to implement a change in practice. As noted during an interview, teachers receive three evaluations that can take place at any moment, "one negative observation can have a very negative impact" on a teacher's overall success for the year.

When combining attitudes expressed by members in both groups, teacher evaluations are perceived as having a very negative impact on teacher creativity. However, the variations expressed toward teacher evaluations in the treatment group are important to highlight, and this difference was also pronounced in teachers' responses during interviews. For example, one treatment group member considered the variation based on previous "experience being evaluated, "stating that it depends on the "view and outlook" a teacher has toward this experience; "some teachers look at evaluations as a gotcha type of thing, I look at evaluation as a place to grow." The teacher said this might be an outcome of her experience and respect in the building. However, another teacher who described herself in a similar way stated, "I don't see anything positive about teacher evaluations." Interestingly, this interview participant had previously explained that her experience in the classroom allows her to veer away from the curriculum a little, but then said, "if I know I'm being evaluated, I stick to the script." When asked if she feels compelled to hide some of the veering away from the curriculum, she responded by saying "that's very accurate." Therefore, although there is some variation among members of the treatment group, like the curriculum, many teachers see evaluations as a barrier to teacher creativity, as they are an enforcement to rules that must not be broken.

Audience. The category audience was originally presented as investigating teacher attitudes toward marketing their creativity. However, during data analysis the concept of how teachers respond to their audience was perceived as a more appropriate way to represent the sharing and promoting of new and useful ideas. As explored in the previous sections, there is a perception that teachers might need to hide their creativity from the administration, which could explain some of the negative responses shared toward this concept and overall value beliefs toward the program. For example, members of the treatment group said, "it is my classroom and I will do what works best for my students and me" and "creativity is a personal thing and doesn't require outside validation." This perspective was shared among members of the comparison group, and there was a suggestion that others might not understanding another individual's creativity, "other people don't usually understand what I do, and it takes a long time to explain creativity to people who don't really understand." This final statement was considered relatable to the idea that "everyone has a different perspective on creativity" and therefore may explain some of the initial reaction toward the challenge rubric.

Although these were prominent statements there were members in the treatment group who felt it “important to show your ideas and get others on board” and helpful “if you are trying to get other people to do things your way.” Therefore, the negative feelings toward this concept were again more prominent for members in the comparison group. Furthermore, it’s possible that the word marketing provoked negative responses, that might otherwise have been different. As stated during an interview “connecting the word marketing, is such a business term” and “creativity is a personal thing and we are all creative in different ways.” Consequently, the question toward the concept of marketing creativity provided insights into how teachers view creativity in relationship themselves and other people who exist in their environment (e.g., students, administrators).

Failure. When addressing the question on how incidents of failure impact teacher creativity, most teachers in the comparison group initially considered failure as something that supports creativity, as “while we don’t enjoy it, it is our greatest teacher” and “we learn more from our failures than we do from our successes.” Although some members of the treatment group expressed similar views toward failure, there was greater acknowledgement that the impact failure “can work either way – be a driver for change or result in discouragement” and when this happens failure can make “teachers give up” and worse “act as a deterrent towards change in practice.”

Value Beliefs. Value beliefs toward expressed attitudes for teacher creativity considered whether this concept supports teacher’s when challenged to make changes in practice. Members of the comparison group expressed beliefs that creativity is important when challenged to adopt something new in the classroom “Creativity and open-mindedness are very important” and “creativity requires imagining something new, so this would be important when adopting something new." However, this question did initiate a response that reiterated how environmental factors might contribute to how teachers value the concept of creativity within their practice "I don't know that teachers believe that integrating something new means adding creativity, often things are thrust upon teachers without a thought as far as creativity." This view was supported by another teacher during interviews "very well said, because that surmises a lot of attitudes that I see on a daily basis."

Members of the treatment group overwhelmingly expressed positive attitudes toward the impact teacher creativity has on changes in practice. "I think creativity will help when trying out something new" and "creativity is incredibly important because it can bring life and fun into the classroom." This final statement might again revisit the concept that teachers at the school are tasked with implementing a prewritten curriculum that some view as not adequately engaging students attention.

Observed Changes

Treatment group. Attitudes toward teacher creativity remained mostly unchanged after the program; however, there were some subtle differences. Some members of the treatment group were no longer explicit in the concept toward novelty when expressing their understanding toward teacher creativity. Although references such as "bringing ideas", "finding ways", and "create tasks," could be replacement words for this concept, it's interesting to note that the word new and different was absent from all responses.

This change was accompanied with more explicit references toward engagement, with seven out of the eight treatment members including this word in their response to the question of how teacher creativity is defined. For example, in the pre-survey a teacher stated “teacher creativity is when the teacher goes out of their way to bring new and exciting ideas and activities designed to engage a variety of learners,” but in the post-survey they presented teacher creativity as “being able to consistently engage students in a variety of ways while meeting their particular needs.” Another pre-survey response changed from “using methods that inspire and interest students” to “using all resources available to address needs of students in ways that engage them and produce results.” Although the latter is a similar response when compared to the pre and post survey, the inclusion of addressing student needs and producing results is considered a subtle change in how the outcome is potentially measured and relevant in this investigation.

There were also some changes in how members of the treatment group viewed teacher evaluations; during the pre-survey only one teacher expressed negative feelings toward the impact of teacher evaluations on teacher creativity, while other members said “it depends on the department you work for” and “teacher evaluations have the potential to stifle or support creativity”. However, in the post-survey negative feelings toward teacher creativity became more pronounced among members of the treatment group with five out of eight members expressing negative feelings, such as “teacher evaluations influence my creativity a great deal because I feel like I am too restricted by my curriculum and my evaluations are based on how well I am adhering to the curriculum.” It is difficult to infer whether this change was a consequence of participation in the program; from one perspective this change could be a result of greater reflection and understanding toward the concept of teacher creativity. Whereas, another view could present the change as another indication that teacher attitudes toward creativity were influenced by other experiences that took place during the program (e.g., a teacher evaluation).

Comparison group. Like the treatment group, most attitudes toward teacher creativity remained unchanged, but again there were some subtle differences in how comparison group members defined teacher creativity. Initial variations toward an understanding of this construct became more focused toward the concept of novelty and student engagement. This was unlikely a result of participation in the challenge and more likely a consequence of addressing the question from the perspective of the teacher, as opposed to the student. For example, in the pre-survey a participant defined teacher creativity "as teaching students to think for themselves and problem solve in any content area, but in their post survey they stated "teacher creativity is a teacher using whatever they need/ have on hand to inspire students to learn."

There were also changes in attitudes toward failure, with one member moving from wanting to define failure "before it can change a practice" toward the statement "if reflected upon, failure may be helpful; or it may be soul-killing" and these two views were further clarified by another member of the comparison group who initially considered failure as something that "makes people more afraid" changed to "failure improves, but failure related to a supervisor stifles creativity."

Finally, although attitudes toward beliefs that teacher creativity is important when adopting something new remained constant for some comparison group members, there was evidence of a changes in attitude toward the value of teacher creativity in others. For example, one participant initially shared the belief that teacher creativity "is very important to adopt something new" moved to seeing teacher creativity as "not important at all”, while another started with “creativity requires imagining something new, so this would be important when adopting something new” and then changed to “new ideas and practices require an open mind, but not necessarily creativity”. When discussing this perspective during an interview with a comparison group member, they considered this final statement to represent the “two sides of teaching”:

> you’re hearing about the freedom that teachers want to be able to improve, to experiment, to be creative, and grow in their teaching practice, and at the same time the limitations that are being placed on us by the way we are being evaluated, and to certain extent, depending on the subject, the curricula and how we are expected to follow it

Self-Assessment

As discussed at the beginning of this chapter, the investigation did not use an external group of professionals to evaluate outcomes produced for the C2032 challenge. Instead, teachers were invited to complete a short self-assessment survey where they described the situation as it existed before and after the C2032 challenge. The form also asked teachers to signify whether they considered the outcome as creative, while requiring an explanation for this decision. Some members provided minimal information in response to these questions, and as a consequence data from the self-assessment was insufficient to conduct a valid evaluation of the outcomes using the C2032 rubric. Nevertheless, the data did provide information on how many teachers ranked their outcomes as being creative, which is shown as a percentage in Figure 5.7.

Figure 5.7: Self-Assessment

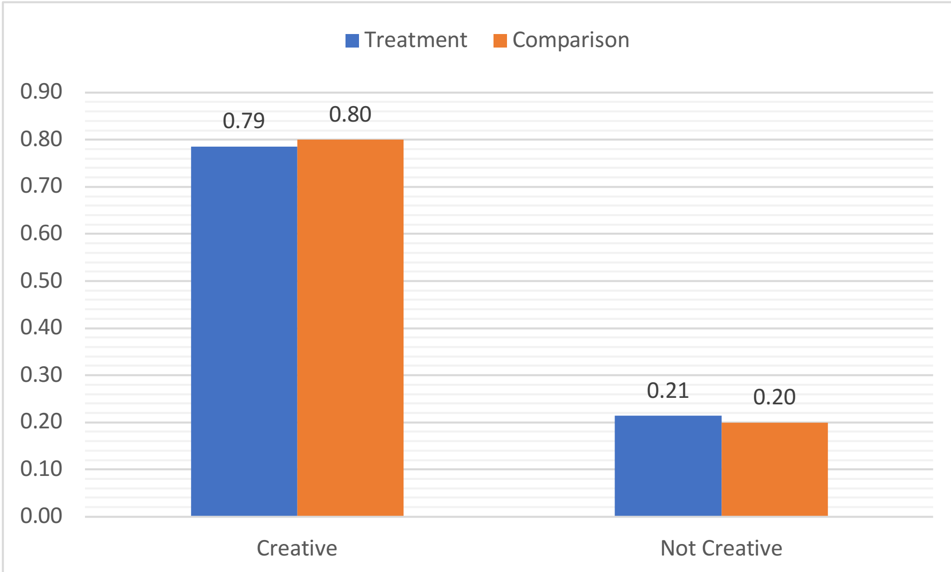

Figure 5.7: The number of participants with outcomes ranked as creative during the self-assessment.

Despite the weakness of this instrument, it did provide some additional information in how teachers in either group viewed their outcome. As discussed earlier in this section, teachers overwhelming saw teacher creativity as something to increase student engagement. However, only one member of the treatment group and two members of the comparison group made specific reference to using the technology to address this concern.

Most teachers in the treatment group made reference to defined problems in practice, such as “exit tickets were created on paper. Collecting data and having it available in a useful way was very time-consuming” and “I honestly did not address students' first language in the classroom setting. While majority of my students read, write, and understand English, it is helpful for them to be able to see these English words in their native language.” Whereas in the comparison group there were greater incidents of technology focused implementations that did not always specify a definite problem of practice. For example, "Google Classroom was already in use, but not being used to answer questions from students" and "Google slides to give presentation. No sounds or voice over." For members of this group, there were also incidents of using technology to increase active learning, which might offer additional attention toward student engagement by other members of this group, "the ability to re-teach in a hands- off manner was also limited" and "students were able to complete multiple music technology projects using the program."

Although not conclusive, the perceived higher incidents of defined problems of practice among members of the treatment group might signify an influence of the actions Choose Destination and Chart Course. This view is supported by at least one reference in the self-assessment survey, which appeared to indicate reflection on whether the outcome resolved the problem identified in response to these actions:

> in theory it seemed like a good tool. It has the potential to stop them and then have them answer questions throughout a lesson as a tool of reflection. Upon reflection it seemed like a lot of leg work ahead of time and may not have gotten the job done as a reflection tool. Would students have been able to look back at their responses for the 'reflection' purpose?

This interpretation was presented to participants of the treatment group during the post-program interviews, with one member providing a specific connection to the problem-statement and its influence on their intended outcome:

> it focused, this is what I want to do, this is what I'm trying to do, what am I going to use to do that… and I looked back at that problem-statement I wrote, when I

tried to mess around with the technology I was going to choose, and ultimately decided that it didn't solve my problem

Although another member of the treatment group didn't provide a specific connection between the problem-statement and their final outcome, they did agree with the view that problem-statements can focus attention toward specific issues to address, "I think too much in teaching, or in life, we don't make specific problem statements, we too often say that lesson sucked" and "in order to come up with the best solution, or the best brainstorming of possible solutions, you do need to have that specific problem-statement."

However, there were incidents of defined problems of practice from members in the comparison group, and it's important to highlight that when completing the self-assessment surveys, the number of participants from this group was higher than those received from the treatment group. Nevertheless, it also remains possible that some of the references toward defined problems was a result of the contamination that occurred during the third workshop. However, without that contamination occurring, the study may have found a higher volume of technology focused outcomes or outcomes related to increasing student engagement.

Conclusion

Before addressing the second outcome evaluation question, it is important to acknowledge the prominent themes that emerged from the qualitative date contained in this study. As presented in Figure 5.5, these themes appear to influence teacher attitudes toward teacher creativity, and therefore the challenge to produce a creative outcome using new technology. Content presented within the workshops did not adequately address these themes, which primarily consisted of external factors within a teacher's professional environment. Furthermore, continued references to student engagement, teacher evaluations, and the curriculum, suggest that a teacher's environment can be separated into three distinct units of focus; classroom, department, and school/district.

Figure 5.5: Influential Themes on Teacher Creativity

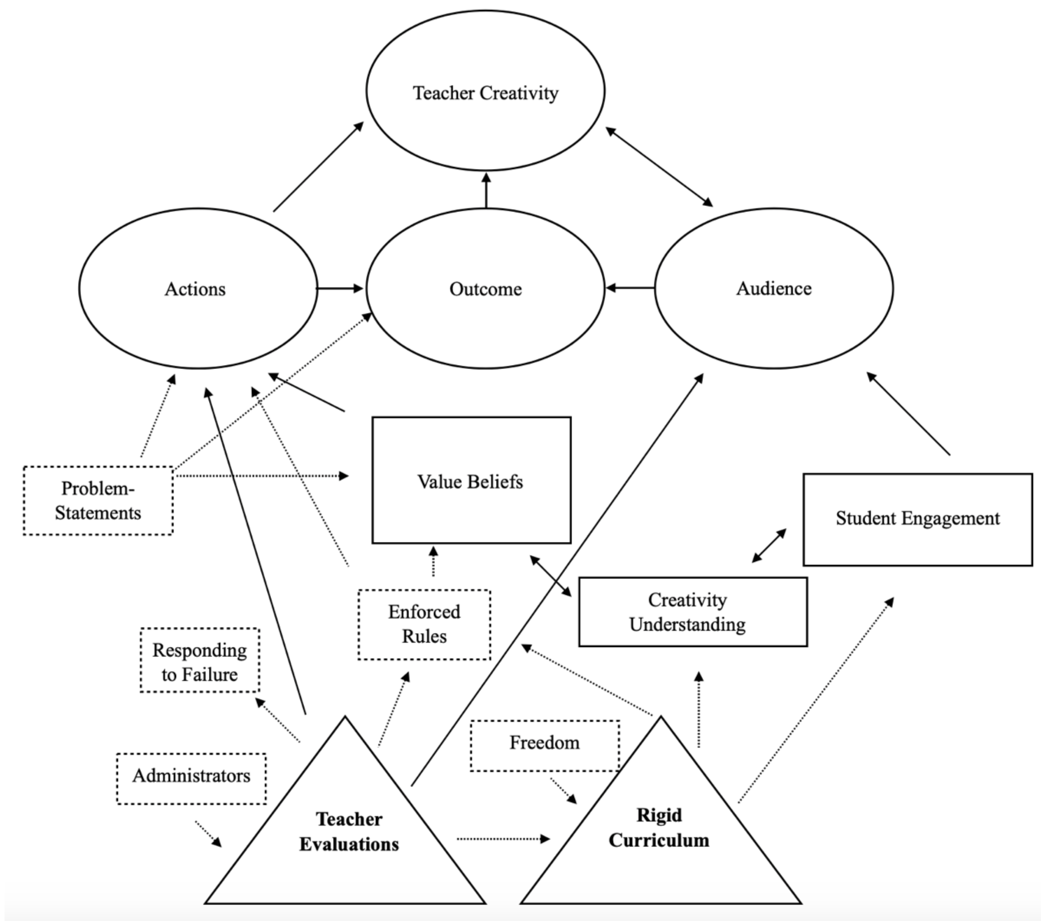

Figure 5.5. Presents prominent themes during the program's implementation, where were referenced by at least two people on post workshop surveys. Themes were reviewed and confirmed during post-program interviews.

It is also important to acknowledge that these environmental factors influenced how teachers responded to the C2032 challenge, and weak adherence to the final two actions for teacher creativity make it different to offer a valid inference when comparing observed outcomes between the two experimental groups. Nevertheless, there were differences represented in data captured using the SoC, teacher creativity questionnaire, and self-assessment survey (see Table 5.5).

At the end of the program, teachers in the treatment group seemed less focused toward novelty and more intent toward producing an outcome that addressed a specific problem of practice. Likewise, members of this group maintained positive attitudes toward the influence of teacher creativity when challenged to adopt something new, which varied more amongst members of the comparison group. These two factors might contribute to the differences in concerns toward the challenge as expressed at the end of the program. Although, both groups showed concerns for other priorities, the intent to address a problem of practice might have maintained some level of interest from members of the treatment group. Whereas the observed resistance by members of the comparison group might be attributed to the belief that they do not have the capacity to be creative within their environment. Alternatively, the technology focused approach by some members of this group might suggest simply using the application was viewed as satisfying the challenge, and therefore they considered their work as being completed.

Table 5.5

Comparison Table (Process and Outcome Evaluation)

Group	Treatment Group	Comparison Group
Change	At the beginning of the program, participants of the treatment group expressed higher concerns to other priorities, though had some interest in learning more about the challenge and how it might impact	At the beginning of the program, participants of the comparison group expressed higher concerns to other priorities, though had some interest in learning more about the challenge and how it might impact their

	their existing practice. These concerns remained unchanged when measured at the end of the program.	existing practice. These concerns changed when measured at the end of the program, with indications of resistance toward the challenge and a desire to move on to other tasks.
Attitudes	When asked to define teacher creativity, participants in the treatment group expressed attitudes toward novelty and student engagement. The latter remained at the end of the program, though there was a significant reduction in the concept toward novelty. Attitudes toward constraints, failure, and teacher evaluations provoked negative attitudes toward the curriculum and administration, which was perceived as a barrier to teacher creativity using new technology. These attitudes remained mostly unchanged when measured at the end of the program. Members of the treatment group overwhelmingly expressed positive attitudes toward the impact teacher creativity has when challenged to adopt something new.	When asked to define teacher creativity, participants in the comparison group expressed attitudes toward novelty and student engagement. The former strengthened at the end of program, while the concept toward student engagement remained. Attitudes toward constraints, failure, and teacher evaluations provoked negative attitudes toward the curriculum and administration, which was perceived as a barrier to teacher creativity using new technology. These attitudes remained mostly unchanged when measured at the end of the program. Members of the comparison group were less unified when considering the impact teacher creativity has when challenged to adopt something new, with some feeling constrained in their capacity to response creatively during these events.
Outcomes	The majority of treatment group members considered the outcome they produced from the C2032 challenge as being creative, though some outcomes were still in development. The majority of members in the treatment group focused their outcomes toward problems of practice other than increasing student engagement.	The majority of comparison group members considered the outcome they produced from the C2032 challenge as being creative, though some outcomes were still in development. Some members in this group focused their outcomes toward problems of practice, others focused on expanding existing use of technology, while others looked toward increasing student engagement.

Note: This table provides a short overview of findings from the SoC, creativity questionnaire and self-assessment rubric.

When presenting these differences, there are two independent variables to examine; the first considers whether the beginning two stages of the treatment influenced teachers enough to produce the observed changes. Findings within the qualitative data suggest this activity helped teachers in the treatment group focus on a problem to address during the challenge, and for at least one teacher this guided ongoing reflection and judgement during development of that outcome. Furthermore, as presented in the theory of treatment, the two actions of choose destination and chart course were expected to produce this result, which was observed within the self-assessment. However, without an external group of judges to evaluate these outcomes, there is the possibility of participant bias and internal bias when considering data from this instrument. Furthermore, there is evidence of outcomes focused toward problems of practice from members of the comparison group, and it is not possible to know if these were a consequence of the known contamination that took place during the third workshop.

The second independent variable considers the initial differences in attitude expressed by members of the two experimental groups at the beginning of the study. There were no statistical differences found in self-efficacy scores or quality of instruction, and influential factors within the environment were prominent for members of both groups. However, there were subtle differences in initial attitudes expressed toward the concept of teacher creativity. It is possible these attitudes were the result of concerns toward the study as discovered during the process evaluation. Alternatively, it may mean members of the comparison group started with a different understanding toward this concept, and therefore struggled to engage in the challenge. The conditions of this study make it difficult to know for sure, but nevertheless it does mean we are unable to make an inference toward the influence of C2032 on teacher creativity.

Discussion

This dissertation study set out to address the challenges of teacher change in response to new technology introduced as a consequence of an authority innovation-decision (see Rogers, 2003). This topic of focus was identified, as methods used for technology procurement do not always consider evidence-based research in the decision-making process and fail to produce sufficient change in the classroom to justify the investment (Cuban, 2013). Furthermore, when technology is introduced by an authority (e.g., principle), it can occur without providing teachers with adequate training or vision for how the technology can improve an individual's practice. Consequently, some teachers may choose to ignore the technology, while others use it to support an existing instructional approach. Although the latter may constitute adoption, it may not necessarily improve the learning experience when comparing the outcome to what existed before.

Class of 2032: Design the Future, was a professional development program that promoted a design-based approach when changed to use new technology under these conditions. This intervention was developed using existing literature on creativity, as this study posits that creativity aligns with the overall goal of meaningful change in the classroom. Focusing on creativity at the individual practitioner level offers a new topic to explore when working toward an improved learning experience using new technology. Although the concept of teacher creativity may be viewed as an oxymoron in education (Bramwell et al., 2011), this study argued that creative problem-solving methods could assist teachers in making valued connections to new technology from the perspective of how they may address a problem of practice. Furthermore, creativity research offers suitable frameworks to investigate potential barriers to teacher creativity while also providing ways to measure meaningful changes produced as a consequence of new technology.

Challenges experienced during implementation of the program included changes to the schedule, which resulted in a longer duration between workshops, and times constraints that led to weak adherence to the last two stages of treatment. Furthermore, general concerns about the study led to ongoing questions about the differences between the two experimental groups. While existing grievances toward professional development and methods used for gathering data at the school appeared to exasperate these issues further. As a result, some teachers felt they had insufficient time to engage in the challenge, while others seemed to be reluctant to participate in the program.

As a consequence of these challenges, participation in the study was low. Some data also proved insufficient to make valid inferences toward the impact of the C2032 program and teacher creativity using new technology. Although the program did appear to facilitate the exploration of multiple applications, it was unclear whether the outcomes produced from the challenge delivered a meaningful change in practice. This problem was primarily associated with weak execution of the self-assessment survey, which was particularly impacted by the difficulties during implementation. Some teachers expressed concern about using an external group of professionals to evaluate outcomes produced in response to the C2032 challenge.

Furthermore, the use of a creativity rubric appeared to conflict with some existing views of creativity. Consequently, a self-assessment activity was offered to conduct an evaluation of artifacts produced with the new technology, while also appeasing participant concerns. However, the data gathered from this activity proved insufficient to evaluate the outcomes generated from the program.

Most teachers evaluated their outcome as creative, even when there was little evidence that they had enacted their idea. This experience may result from the varying views of teacher creativity, particularly those that think "a person's creativity is personal." Furthermore, some participants offered minimal information about their situation as it existed before and after the C2032 challenge. This situation made it difficult to evaluate and compare teacher creativity during data analysis. Had there been more information gathered about the artifacts, further insights into the results from the SoC may have been possible. For example, the perceived resistance expressed by some members of the comparison group may have resulted from a belief that they had satisfied the needs of the challenge by simply implementing new technology. Likewise, data about the artifact may determine whether members of the treatment group did focus more on a problem of practice. Evidence suggests that at least one treatment group member viewed their outcome as not creative because they determined that it did not adequately address the problem statement they created during the initial stages of the program. This finding suggests a potential benefit of the treatment, which tasked teachers with producing a problem-statement as part of the first two actions of teacher creativity. However, without sufficient data about the outcomes generated from the C2032 challenge, it is impossible to determine if a focus on the problem was common among other members. This experience emphasizes the need to include a thorough evaluation of outcomes produced during a future implementation of the program. However, more considerable attention must be made to address teacher concerns toward the evaluation of outcomes. At the same time, more work is needed to clarify teacher creativity before tasking teachers with a self-assessment.

Despite these challenges, some important findings contribute to future research on teacher creativity using new technology. First, the study participants appeared to struggle with the ambiguity of teacher creativity, perhaps as a consequence of common stereotypes associated with this construct that occur more widely in society (Plucker et al., 2004; Plucker & Dow, 2010; 2016). For example, data obtained from the pre-survey suggest a focus on novel outcomes, which appeared difficult to obtain under environmental constraints (i.e., a rigid curriculum). Teachers reported not understanding how creativity connects to their work in the classroom while also presenting obstacles such as a rigid curriculum. In their work toward a creativity enhancement model, Plucker and Dow (2016) identify the need to address the ambiguity of creativity by explicitly challenging some of the stereotypes as part of creativity training. This study would require a greater focus on the concept of useful outcomes as they relate to a teacher's environment while also addressing some of the perceived constraints that emerged during the investigation. This avenue would mean future iterations of the C2032 program should focus more on teacher creativity, as it relates to time-constraints, teacher evaluations, and a rigid curriculum. Furthermore, emphasizing the need to produce an outcome that is useful and novel should become more explicit within the material, including any tools used to conduct evaluations.

Building on the first finding, members of the treatment group appeared to improve their understanding of the concept of teacher creativity. Data obtained from the pre-survey suggested teacher creativity was widely viewed as a way to increase student engagement in the curriculum, while also being strongly associated with novelty. As already discussed, this view of creativity is prevalent within society. However, members of the treatment group appeared to have a different look of teacher creativity after the program had ended, with a significant reduction in focus toward novelty. Creativity involves the production of new outcomes, but outcomes that are also viewed as useful within a specified context (Plucker et al., 2004). Rather than emphasizing novelty, teacher definitions in the treatment group appeared to address student needs, with an increase in emphasis toward engagement. Therefore, this change in attitude may indicate an increased awareness toward the latter, and consequently, a challenge toward a potential view that technology implementation alone serves as teacher creativity.

This finding contributes to the literature because it highlights a potential view of teacher creativity among teachers. Future research on this topic should consider whether increased student engagement is sufficient to justify technology procurement, and if it is, what impact does this have on the learning experience.

This study works in support of the autonomy teachers appear to have when tasked with using new technology introduced as a consequence of an authority innovation-decision. Consequently, if creative outcomes using new technology are dedicated to student engagement, what support are teachers receiving to effectively measure technology use with a focus toward this outcome. Schindler, Burkholder, Morad, and Marsh (2017), present three different forms of student engagement when using new technology; behavioral engagement considers the increased commitment in time dedicated to the task, emotional engagement captures student's reported like of the technology or activity, and cognitive engagement represents a commitment to the cognitive actions associated with the learning process.

In their literature review, Schindler et al. (2017) call for a greater understanding of technology use and its relationship with student engagement. If we can increase knowledge within this area, teachers may be better positioned to evaluate creative outcomes using new technology. Furthermore, this knowledge can inform future uses of the 4-C model when using this framework to guide evaluations of teacher creativity using new technology. Mini-c creativity may allow for experimentation of ideas using new technology, but progression toward pro-c outcomes of creativity should include evidence-based research that demonstrates increased student engagement as a consequence of those actions. More importantly, teachers should have the capacity to evaluate how increased engagement improved the overall learning experience.

Considerations for Future Study

Despite a lack of evidence to suggest the prescribed treatment increased overall teacher creativity, the investigation did discover potential opportunities for future study related to the concepts presented in choose destination and chart course. These two initial actions task teachers with selecting a problem of practice they want to address, and then focusing their efforts toward the use of new technology to address these problems. When engaging in these actions, teachers adopt a design mindset, which promotes divergent and convergent thinking in response to an ill-defined problem. The divergent thinking encourages teachers to challenge existing routines, while the convergent thinking helps teachers focus on a problem they value addressing. The result of these actions produces a defined problem-statement used to guide exploration and implementation of the technology. This action was valued by participants in the treatment group, with some evidence to suggest it helped teachers address the challenge. More importantly, the study did not disprove that these initial actions can help increase teacher creativity when challenged to use a new technology introduced as a consequence of an authority innovation-decision. There is also indication in the study that the existence of a problem-statement may support reflection and a likely course correction once determined an initial idea is unlikely to produce the intended result. Therefore, future research could investigate how problem-statements contribute to a teacher's creative process, while also helping to evaluate creative outcomes produced.

Although the investigation into teacher creativity did not produce any substantial results toward the four actions for teacher creativity, it did reveal the influence of environmental factors that appeared to impact teacher creativity using new technology. These factors include teacher evaluations, the curriculum, and student engagement. Furthermore, these factors seem to influence attitudes toward failure, perceived opportunities for creativity, and considered preferences from the administration. Consequently, these findings provide greater insight into teacher creativity and how it might exist within Glaveanu's five-A framework for creativity (see Figure 5.6).

Figure 5.6: Five A Framework for Teacher Creativity

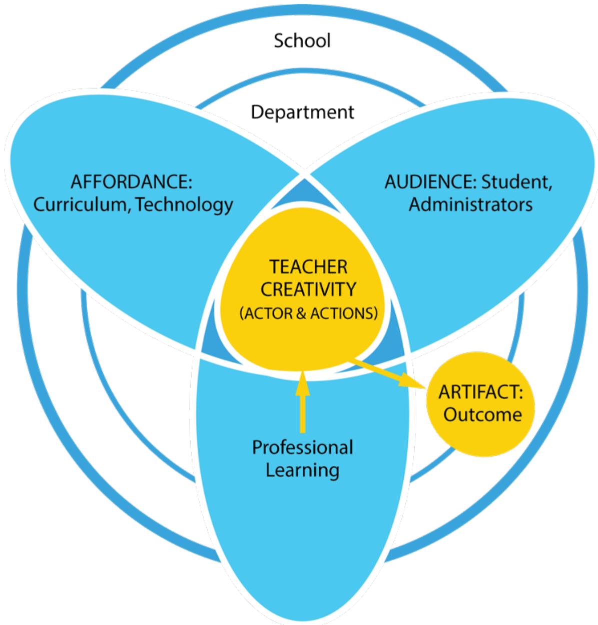

Figure 5.6. Presents a modification of the five-A framework for teacher creativity, based on the discovery of factors that exist within the school's environment. Findings of this study indicate these factors were influential in teacher creativity, as presented within this study.

The existence of influential factors within a teacher's environment highlight opportunities for future investigation into the relationship of intrinsic and extrinsic motivations that exist within a teacher's professional content (Amabile, Hill, Hennessey, & Tighe, 1994). Research by Amabile (1993), might provide an initial basis for this type study and introduces an avenue of research similar to current investigations into employee creativity in the workplace (Kuvaas, Buch, Weibel, Dysvik, & Nerstad, 2017; Zhou, Zhang, & Montoro-Sánchez, 2011).

Another consideration for future research is the level of change that comes about from a program designed to promote teacher creativity. This would bring future studies on this topic closer to the existing work on teacher change (Anderson, 2017; Spillane, Reiser, & Reimer, 2002) and professional growth (Clarke & Hollingsworth, 2002;

Darling-Hammond et al., 2017; Desimone & Garet, 2015). It would also provide an opportunity to further explore the impact of the first two stages for teacher creativity and whether identifying a problem statement does indeed help teachers identify and measure a valued outcome during the change process. However, this would require significant improvement toward the methods used to evaluate outcomes produced from the C2032 challenge.

Finally, future iterations of the C2032 program must better address the environmental factors that influence teacher creativity, while also including greater direction and more opportunities to explore technology. This might mean a change in approach to the inclusion of an ambiguous creativity challenge, and a reduction in how much selection is provided toward the technology. Data from the self-assessment suggest multiple applications were explored as part of the C2032 challenge, while requests for more guidance of the technology was a common occurrence within the workshop surveys. Focusing on one or a few applications, would make it easier to address requests for greater technology support.

Limitations

Although the study presented a number of limitations associated with the process evaluation and different starting attitudes toward teacher creativity, low participation in the study and an initial resistance to the program impacted the investigation into teacher creativity at the research site. Outside the discovery of environmental factors, most observed outcomes might be a consequence of second-order barriers, which is known to influence technology use under these conditions. The low participation in the data collection makes it difficult to completely rule out the impact of varying levels of self-efficacy, and it was not possible to investigate teacher creativity at the school by department or number of years teaching. These two factors were presented as possible influences during the post-program interviews.

There were also limitations discovered when administering the instrument. Despite instructions, teachers seemed confused about some of the statements presented in the SoC questionnaire, which is a factor highlighted within the instructions of the survey (George et al., 2013). Furthermore, it’s interesting that results of the SoC were not too different to those expressed toward the G-suite platform during the initial needs assessment. Therefore, teachers may simply have had the same concerns toward the G-platform, or it may signify challenges in using the SoC instrument when measuring teacher concerns of a technology with multiple applications. Alternatively, it’s possible the pre-program survey captured concerns impacted by the initial ambiguity of teacher creativity, while the post-program survey may have captured concerns impacted by other factors. The possibility that the complexity of the C2032 challenge impacted the construct validity as measured using the SoC questionnaire is supported within the literature (Cheung, Hattie, & Ng, 2001; Cheung & Yip, 2004). Fischer, McCoy, Foster, Eisenkraft, and Lawrenz (2019), posit that teachers faced with complex challenges may respond to SoC questions from different perspectives of the proposed innovation. As the SoC questionnaire investigated teacher concerns toward the C2032 challenge, it’s possible that some teachers may have responded from the perspective of teacher creativity, while others responded to the technology or contextual factors within the environment.

Another limitation associated with the SoC instrument related to its administration within the study. Hall and Hord (2015) present the SoC questionnaire as a tool to monitor teacher change during the implementation of an innovation. As a consequence of weak participation in the process survey administered halfway through the program, information for teacher concerns was limited to the data gathered from the pre and post program survey only. Consequently, the study was unable to report teacher concerns toward the C2032 challenge beyond the beginning and end of the intervention. This is problematic for two reasons; the SoC instrument is sensitive to time and contextual factors (Fischer, McCoy, Foster, Eisenkraft, & Lawrenz, 2019; Gwele, 1997; Kwok, 2014). Given the time that passed between workshops and the likely fact that some teachers would have experienced teacher evaluations during these periods, it is possible that teacher concerns toward the C2032 challenge would have been different at varying stages of the C2032 program. Although, Hall (2010) suggests a general progression through the stages of concern, Fischer et al. (2019), highlight this may not always be the case. Therefore, having SoC data from teachers during the program would have provided greater insight into overall participation in the challenge, and the possible changes in concerns that took place during implementation. This may have shown greater concerns in the management and impact stages during program implementation, particularly if the questionnaire was administered soon after participation in workshops. Alternatively, the data may have shown a steady progression toward the final results presented in this study, therefore offering increased validity.

Finally, researcher bias remains a factor when interpreting qualitative data, particularly regarding the interpretation of creative outcomes. Unfortunately, this investigation took place during the early stages of the Covid-19 outbreak, and consequently it was not possible to hold focus group interviews to further an understanding into the observed differences between the two experimental groups. Nevertheless, a method of member checking was deployed as an alternative with teachers who volunteered to provide feedback on initial interpretations of the qualitative data as part of interviews conducted through zoom. These interviews confirmed what was presented in this study; however, they also highlighted that some of the observed changes in attitude might be a consequence of recent teacher evaluations or simply an outcome of an increasingly busy year as the study progressed. There were also concerns in how the program was introduced, which were related to previous professional development experience at the school. These concerns contributed as a factor that was difficult to monitor and beyond the scope of this investigation. Therefore, significant caution is advised when interpreting findings beyond the discovery of environmental factors.

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Appendix A

Needs Assessment Survey

This questionnaire is part of a study to investigate the introduction of new technology in the classroom.

By participating in the questions below, you are signifying your consent for the survey. Your responses are voluntary and your identity is kept confidential. The information gathered will be compiled together and what you share will remain anonymous.

The questionnaire will take approximately 12-15 minutes to complete, and you are free to stop at any time.

Please complete the following.

A1 Gender

- ○ Female (1)
- ○ Male (4)

A2 Number of years teaching (including this year)

- ○ 1-2 years (1)
- ○ 3-5 years (2)
- ○ 5 years or more (3)

A3 Number of years teaching at Westside Middle School Academy (including this year)

- ○ 1 year (1)
- ○ 2 years (2)
- ○ 3 years (3)
- ○ 4 years or more (4)

Please read the following introductory statement carefully

The purpose of the next section is to determine the level of use and concerns toward an innovation (e.g., a new technology).

The questions in this section were developed from typical responses of school and college teachers who ranged from no knowledge at all about the innovation to many years' experience in using the innovation. Therefore, a good portion of the items in this section may appear to be of little relevance or irrelevant to you at this time. **For the completely irrelevant items, please circle "0" on the scale.**

Instructions

Please mark one category that best indicates your overall level of use for the G Suite (formally Google Apps). The G Suite includes Docs, Sheets, Slides, Forms, and Sites, as well as services such as Hangouts and Google+.

As you review each statement consider the context of your level of use for the G Suite in the classroom. Indicate the extent to which each concern is true by marking a number on the 0–7 scale next to each statement. High numbers indicate high concern; low numbers, low concern; and 0 indicates very low concern or completely irrelevant item.

Please respond to the items in terms of your present concerns, or how you feel about your involvement or potential involvement with the G Suite (formally Google Apps)

Remember to respond to each item in terms of your present concerns about your involvement or potential involvement with the G Suite (formally Google Apps).

Remember, high numbers indicate high concern; low numbers, low concern; and 0 indicates very low concern or completely irrelevant item.

B1. I am concerned about students' attitudes toward the G Suite (Google Apps).

- ○ 0 (61)
- ○ 1 (62)
- ○ 2 (90)
- ○ 3 (91)
- ○ 4 (92)
- ○ 5 (93)
- ○ 6 (94)
- ○ 7 (95)

B2. I now know of some other approaches that might work better.

- ○ 0 (1)
- ○ 1 (2)
- ○ 2 (3)
- ○ 3 (4)
- ○ 4 (5)
- ○ 5 (6)
- ○ 6 (7)
- ○ 7 (8)

B3. I am more concerned about another innovation.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

B4. I am concerned about not having enough time to organize myself each day.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

B5. I would like to help other faculty in their use of the G Suite (Google Apps).

- ◯ 0 (1)
- ◯ 1 (2)
- ◯ 2 (3)
- ◯ 3 (4)
- ◯ 4 (5)
- ◯ 5 (6)
- ◯ 6 (7)
- ◯ 7 (8)

B6. I have a very limited knowledge of the G Suite (Google Apps)

- ◯ 0 (1)
- ◯ 1 (2)
- ◯ 2 (3)
- ◯ 3 (4)
- ◯ 4 (5)
- ◯ 5 (6)
- ◯ 6 (7)
- ◯ 7 (8)

B7 . I would like to know the effect of reorganization on my professional status.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

B8. I am concerned about the conflict between my interests and my responsibilities.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

B9. I am concerned about revising my use of the G Suite (Google Apps).

○ 0 (1)

○ 1 (2)

○ 2 (3)

○ 3 (4)

○ 4 (5)

○ 5 (6)

○ 6 (7)

○ 7 (8)

B10. I would like to develop working relationships with both our faculty and outside faculty using the G Suite (Google Apps).

○ 0 (1)

○ 1 (2)

○ 2 (3)

○ 3 (4)

○ 4 (5)

○ 5 (6)

○ 6 (7)

○ 7 (8)

B11. I am concerned about how the G Suite (Google Apps) affects students

- ○ 0 (1)
- ○ 1 (2)
- ○ 2 (3)
- ○ 3 (4)
- ○ 4 (5)
- ○ 5 (6)
- ○ 6 (7)
- ○ 7 (8)

B12. I am not concerned about the G Suite (Google Apps) at this time.

- ○ 0 (1)
- ○ 1 (2)
- ○ 2 (3)
- ○ 3 (4)
- ○ 4 (5)
- ○ 5 (6)
- ○ 6 (7)
- ○ 7 (8)

B13. I would like to know who will make the decisions in the new system.

- ○ 0 (1)
- ○ 1 (2)
- ○ 2 (3)
- ○ 3 (4)
- ○ 4 (5)
- ○ 5 (6)
- ○ 6 (7)
- ○ 7 (8)

B14. I would like to discuss the possibility of using the G Suite (Google Apps).

- ○ 0 (1)
- ○ 1 (2)
- ○ 2 (3)
- ○ 3 (4)
- ○ 4 (5)
- ○ 5 (6)
- ○ 6 (7)
- ○ 7 (8)

B15. I would like to know what resources are available if we decide to adopt the G Suite (Google Apps).

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

B16. I am concerned about my inability to manage all the G Suite (Google Apps) requires.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

B17. I would like to know how my teaching or administration is supposed to change.

- ◯ 0 (1)
- ◯ 1 (2)
- ◯ 2 (3)
- ◯ 3 (4)
- ◯ 4 (5)
- ◯ 5 (6)
- ◯ 6 (7)
- ◯ 7 (8)

B18. I would like to familiarize other departments or people with the progress of the G Suite (Google Apps).

- ◯ 0 (1)
- ◯ 1 (2)
- ◯ 2 (3)
- ◯ 3 (4)
- ◯ 4 (5)
- ◯ 5 (6)
- ◯ 6 (7)
- ◯ 7 (8)

B19. I am concerned about evaluating my impact on students.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

Continue to mark one category that best indicates your overall level of use for the G Suite.

As a reminder, high numbers indicate high concern; low numbers, low concern; and 0 indicates very low concern or completely irrelevant item.

B20. I would like to revise the G Suite (Google Apps) instructional approach.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

B21. I am preoccupied with things other than the use of the G Suite (Google Apps).

- ◯ 0 (1)
- ◯ 1 (2)
- ◯ 2 (3)
- ◯ 3 (4)
- ◯ 4 (5)
- ◯ 5 (6)
- ◯ 6 (7)
- ◯ 7 (8)

B22. I would like to modify our use of the G Suite (Google Apps) based on the experiences of our students.

- ○ 0 (1)
- ○ 1 (2)
- ○ 2 (3)
- ○ 3 (4)
- ○ 4 (5)
- ○ 5 (6)
- ○ 6 (7)
- ○ 7 (8)

B23. I spend little time thinking about the G Suite (Google Apps).

- ○ 0 (1)
- ○ 1 (2)
- ○ 2 (3)
- ○ 3 (4)
- ○ 4 (5)
- ○ 5 (6)
- ○ 6 (7)
- ○ 7 (8)

B24. I would like to excite my students about their part in this approach.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

B25. I am concerned about time spent working with nonacademic problems related to the G Suite (Google Apps).

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

B26. I would like to know what the use of the G Suite (Google Apps) will require in the immediate future.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

B27. I would like to coordinate my effort with others to maximize the G Suite (Google Apps) effects.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

B28. I would like to have more information on time and energy commitments required by the G Suite (Google Apps).

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

B29. I would like to know what other faculty are doing in this area.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

B30. Currently, other priorities prevent me from focusing my attention on the G Suite (Google Apps).

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

B31. I would like to determine how to supplement, enhance, or replace the G Suite (Google Apps).

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

B32. I would like to use feedback from students to change the program.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

B33. I would like to know how my role will change when I am using the G Suite (Google Apps).

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

B34. Coordination of tasks and people is taking too much of my time.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

B35. I would like to know how G Suite (Google Apps) is better than what we have now.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

Page Break

Some final questions.

C1 How long have you been involved with the G Suite (Google Apps) in the classroom, not counting this year?

- ◯ Never (1)
- ◯ 1 year (2)
- ◯ 2 years (3)
- ◯ 3 years (4)
- ◯ 4 years (5)
- ◯ 5 years or more (6)

C2 In your use of the G Suite (Google Apps) in the classroom, do you consider yourself to be a:

- ◯ non-user (1)
- ◯ novice (2)
- ◯ intermediate (3)
- ◯ old hand (4)
- ◯ past user (5)

C3
Have you received formal training regarding the innovation (workshops, courses)?

- ◯ Yes (5)
- ◯ No (6)

Appendix B

Logic Model

Program: Class of 2032: Design the Future (C2032)

Situation: Does the four actions of teacher creativity support teachers when challenged to produce a creative outcome using new technology?

Inputs	Outputs		Outcomes -- Impact		
	Activities	*Participation*	*Short*	*Medium*	*Long*
• C2032 program incorporated into PD plan for 2019/2020 • four workshops scheduled plus origination for all teachers participating in C2032 scheduled • final workshop scheduled to evaluate outcomes of the C2032 challenge • teachers volunteer to serve as participants in study. An intervention and control group established	• presentation to introduce C2032 challenge, and challenge rubric • four 60 minute workshops to introduce choose destination, chart course, course correct, and reflect • visit school to discuss program with participating teachers • facilitate closing workshop to evaluate outcomes produced from C2032 challenge	• all participants understand the C2032 challenge, and understand what it means to produce a creative outcome • teachers participate in the C2032 challenge • treatment group apply four actions of teacher creativity to the challenge • with help from colleagues, participants reflect on ideas and determine if they contribute to a meaningful change in practice	concerns as presented within the CBAM framework increase in impact cluster and decrease in the unrelated and self cluster participants develop positive attitudes toward the concept of teacher creativity participants develop positive attitudes toward incidents of failure participants explore new applications associated with the G-suite to address problems of practice participants consider outcomes produced with new technology from a mini-c, little-c, and pro-c perspective	concerns as presented within the CBAM framework continue to increase in impact cluster and decrease in the unrelated and self cluster participants produce mini-c and little c outcomes using applications associated with the G-suite platform participants apply four actions of teacher creativity to other experiences involving the use of new technology	some participants produce pro-c outcomes using applications associated with the G-suite platform teacher creativity is considered a tool teachers use when tasked with using new technology teachers evaluate the impact of new technology based on meaningful change in the classroom

Appendix C

Pre/Post Survey

This questionnaire is part of a study to investigate teacher creativity using new technology.

By participating in the questions below, you are signifying your consent for the survey. Your responses are voluntary, and your identity will be kept confidential. The information gathered will be compiled together, and what you share will remain anonymous.

The questionnaire will take approximately 20 minutes to complete, and you are free to stop at any time.

This questionnaire is in four parts, the first part will gather information about you, the second part will collect information about your sense of self-efficacy in the classroom, and the third part will focus on your concerns toward the C2032 Challenge. The final component is a short creativity questionnaire.

A. **PART 1: Personal Information**

Please complete the following.

Q106 What is your age?

- ○ 18-24 years old (5)
- ○ 25-34 years old (6)
- ○ 35-44 years old (7)
- ○ 45-54 years old (8)
- ○ 55-64 years old (9)
- ○ 65-74 years old (10)
- ○ 75 years or older (11)

A.1 What is your gender?

- ◯ Female (1)
- ◯ Male (5)

A.2 How do you identify your ethnicity?

- ◯ Asian (1)
- ◯ African-American (2)
- ◯ Caucasian (4)
- ◯ Hispanic/Latino (5)
- ◯ Native American (6)
- ◯ Pacific Islander (7)
- ◯ Other (8)

A.3 What subject matter do you primarily teach?

- ◯ Digital Media (1)
- ◯ ELA (2)
- ◯ Fine Arts (e.g., music, art, etc.) (3)
- ◯ Math (4)
- ◯ PE (6)
- ◯ Science (8)
- ◯ Social Studies (9)
- ◯ World Language (10)
- ◯ Other (11)

A.4 How many years have you taught?

- ○ 1-2 Years (1)
- ○ 3-5 Years (2)
- ○ 5 Years or More (3)

A.5 How many years have your taught at Westside Middle School Academy?

- ○ 1-2 Years (1)
- ○ 3-4 Years (2)
- ○ 5-6 Years (3)

A.6 How many years have you used G-Suite applications in the classroom?

- ○ 1-2 Years (1)
- ○ 3-4 Years (2)
- ○ 5-6 Years (3)
- ○ 7 Years or More (5)

B. PART 2: Self-Efficacy

Please indicate your opinion about each of the questions below by marking any one of the nine responses in the columns under each question, ranging from (1) “None at all” to (9) “A Great Deal” as each represents a degree on the continuum.

Please respond to each of the questions by considering the combination of your current ability, resources, and opportunity to do each of the following in your present position.

B.1 How much can you do to control disruptive behavior in the classroom?

- 1. None at All (1)
- 2 (2)
- 3. Very Little (3)
- 4 (4)
- 5. Some Degree (5)
- 6 (6)
- 7. Quite a Bit (7)
- 8 (8)
- 9. A Great Deal (9)

B.2 How much can you do to motivate students who show low interest in school work?

- 1. None at All (1)
- 2 (2)
- 3. Very Little (3)
- 4 (4)
- 5. Some Degree (5)
- 6 (6)
- 7. Quite a Bit (7)
- 8 (8)
- 9. A Great Deal (9)

B.3 How much can you do to calm a student who is disruptive or noisy?

◯ 1. None at All (1)

◯ 2 (2)

◯ 3. Very Little (3)

◯ 4 (4)

◯ 5. Some Degree (5)

◯ 6 (6)

◯ 7. Quite a Bit (7)

◯ 8 (8)

◯ 9. A Great Deal (9)

B.4 How much can you do to help your students value learning?

◯ 1. None at All (1)

◯ 2 (2)

◯ 3. Very Little (3)

◯ 4 (4)

◯ 5. Some Degree (5)

◯ 6 (6)

◯ 7. Quite a Bit (7)

◯ 8 (8)

◯ 9. A Great Deal (9)

B.5 To what extent can you craft good questions for your students?

- 1. None at All (1)
- 2 (2)
- 3. Very Little (3)
- 4 (4)
- 5. Some Degree (5)
- 6 (6)
- 7. Quite a Bit (7)
- 8 (8)
- 9. A Great Deal (9)

B.6 How much can you do to get children to follow classroom rules?

- 1. None at All (1)
- 2 (2)
- 3. Very Little (3)
- 4 (4)
- 5. Some Degree (5)
- 6 (6)
- 7. Quite a Bit (7)
- 8 (8)
- 9. A Great Deal (9)

B.7 How much can you do to get students to believe they can do well in school work?

- 1. None at All (1)
- 2 (2)
- 3. Very Little (3)
- 4 (4)
- 5. Some Degree (5)
- 6 (6)
- 7. Quite a Bit (7)
- 8 (8)
- 9. A Great Deal (9)

B.8 How well can you establish a classroom management system with each group of students?

- 1. None at All (1)
- 2 (2)
- 3. Very Little (3)
- 4 (4)
- 5. Some Degree (5)
- 6 (6)
- 7. Quite a Bit (7)
- 8 (8)
- 9. A Great Deal (9)

B.9
To what extent can you use a variety of assessment strategies?

- ○ 1. None at All (1)
- ○ 2 (2)
- ○ 3. Very Little (3)
- ○ 4 (4)
- ○ 5. Some Degree (5)
- ○ 6 (6)
- ○ 7. Quite a Bit (7)
- ○ 8 (8)
- ○ 9. A Great Deal (9)

B.10. To what extent can you provide an alternative explanation or example when students are confused?

- ○ 1. None at All (1)
- ○ 2 (2)
- ○ 3. Very Little (3)
- ○ 4 (4)
- ○ 5. Some Degree (5)
- ○ 6 (6)
- ○ 7. Quite a Bit (7)
- ○ 8 (8)
- ○ 9. A Great Deal (9)

B.11. How much can you assist families in helping their children do well in school?

- 1. None at All (1)
- 2 (2)
- 3. Very Little (3)
- 4 (4)
- 5. Some Degree (5)
- 6 (6)
- 7. Quite a Bit (7)
- 8 (8)
- 9. A Great Deal (9)

B.12. How well can you implement alternative teaching strategies in your classroom?

- 1. None at All (1)
- 2 (2)
- 3. Very Little (3)
- 4 (4)
- 5. Some Degree (5)
- 6 (6)
- 7. Quite a Bit (7)
- 8 (8)
- 9. A Great Deal (9)

PART 3: Concerns toward new technology

Please read the following introductory statement carefully

The purpose of the next section is to determine the level of use and concerns toward an innovation .

The questions in this section were developed from typical responses of school and college teachers who ranged from no knowledge at all about the innovation to many years' experience in using the innovation. Therefore, a good portion of the items in this section may appear to be of little relevance or irrelevant to you at this time. **For the completely irrelevant items, please select "0" on the scale.**

Instructions

In the C2032 Challenge, you have been asked to produce a creative outcome using one app from the G-Suite you know well, and another app accessible using your Google account that you haven't used before. In this survey we will investigate your concerns toward this challenge - hereby referred to as the "C2032 Challenge".

As you review each statement consider the context of your level of use of the C2032 Challenge. Indicate the extent to which each concern is true by selecting a number on the 0–7 scale next to each statement. High numbers indicate high concern; low numbers, low concern; and 0 indicates very low concern or completely irrelevant item at this time.

Please respond to the items in terms of your present concerns, or how you feel about your involvement or potential involvement in the "C2032 Challenge" as of today.

Remember to respond to each item in terms of your present concerns about your involvement or potential involvement with the C2032 Challenge.

Remember, high numbers indicate high concern; low numbers, low concern; and 0 indicates very low concern or completely irrelevant item.

C.1. I am concerned about students' attitudes toward the C2032 Challenge.

- ○ 0 (61)
- ○ 1 (62)
- ○ 2 (90)
- ○ 3 (91)
- ○ 4 (92)
- ○ 5 (93)
- ○ 6 (94)
- ○ 7 (95)

C.2. I now know of some other approaches that might work better.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

C.3. I am more concerned about another innovation or technology.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

C.4. I am concerned about not having enough time to organize myself each day.

- ◯ 0 (1)
- ◯ 1 (2)
- ◯ 2 (3)
- ◯ 3 (4)
- ◯ 4 (5)
- ◯ 5 (6)
- ◯ 6 (7)
- ◯ 7 (8)

C.5. I would like to help other faculty in their use of the C2032 Challenge.

- ◯ 0 (1)
- ◯ 1 (2)
- ◯ 2 (3)
- ◯ 3 (4)
- ◯ 4 (5)
- ◯ 5 (6)
- ◯ 6 (7)
- ◯ 7 (8)

C.6. I have a very limited knowledge of the C2032 Challenge.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

C.7. I would like to know the effect of reorganization on my professional status.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

C.8. I am concerned about the conflict between my interests and my responsibilities.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

C.9. I am concerned about revising my use of the C2032 Challenge.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

C.10. I would like to develop working relationships with both our faculty and outside faculty using the C2032 Challenge.

- ○ 0 (1)
- ○ 1 (2)
- ○ 2 (3)
- ○ 3 (4)
- ○ 4 (5)
- ○ 5 (6)
- ○ 6 (7)
- ○ 7 (8)

C.11. I am concerned about how the C2032 Challenge affects students.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

C.12. I am not concerned about the C2032 Challenge at this time.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

C.13. I would like to know who will make the decisions in the new system.

- ◯ 0 (1)
- ◯ 1 (2)
- ◯ 2 (3)
- ◯ 3 (4)
- ◯ 4 (5)
- ◯ 5 (6)
- ◯ 6 (7)
- ◯ 7 (8)

C.14. I would like to discuss the possibility of using the C2032 Challenge.

- ◯ 0 (1)
- ◯ 1 (2)
- ◯ 2 (3)
- ◯ 3 (4)
- ◯ 4 (5)
- ◯ 5 (6)
- ◯ 6 (7)
- ◯ 7 (8)

C.15. I would like to know what resources are available if we decide to adopt the C2032 Challenge.

- ◯ 0 (1)
- ◯ 1 (2)
- ◯ 2 (3)
- ◯ 3 (4)
- ◯ 4 (5)
- ◯ 5 (6)
- ◯ 6 (7)
- ◯ 7 (8)

C.16. I am concerned about my inability to manage all that the C2032 Challenge requires.

- ◯ 0 (1)
- ◯ 1 (2)
- ◯ 2 (3)
- ◯ 3 (4)
- ◯ 4 (5)
- ◯ 5 (6)
- ◯ 6 (7)
- ◯ 7 (8)

C.17. I would like to know how my teaching or administration is supposed to change.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

C.18. I would like to familiarize other departments or people with the progress of the C2032 Challenge.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

C.19. I am concerned about evaluating my impact on students.

- ◯ 0 (1)
- ◯ 1 (2)
- ◯ 2 (3)
- ◯ 3 (4)
- ◯ 4 (5)
- ◯ 5 (6)
- ◯ 6 (7)
- ◯ 7 (8)

C.
Continue to mark one category that best indicates your overall level of use for the Google Apps.

As a reminder, high numbers indicate high concern; low numbers, low concern; and 0 indicates very low concern or completely irrelevant item.

C.20. I am preoccupied with things other than the use of the C2032 Challenge.

- ○ 0 (1)
- ○ 1 (2)
- ○ 2 (3)
- ○ 3 (4)
- ○ 4 (5)
- ○ 5 (6)
- ○ 6 (7)
- ○ 7 (8)

C.21. I would like to revise the C2032 Challenge instructional approach.

- ○ 0 (1)
- ○ 1 (2)
- ○ 2 (3)
- ○ 3 (4)
- ○ 4 (5)
- ○ 5 (6)
- ○ 6 (7)
- ○ 7 (8)

C.22. I would like to modify our use of the C2032 Challenge based on the experiences of our students.

- ○ 0 (1)
- ○ 1 (2)
- ○ 2 (3)
- ○ 3 (4)
- ○ 4 (5)
- ○ 5 (6)
- ○ 6 (7)
- ○ 7 (8)

C.23. I spend little time thinking about the C2032 Challenge.

- ◯ 0 (1)
- ◯ 1 (2)
- ◯ 2 (3)
- ◯ 3 (4)
- ◯ 4 (5)
- ◯ 5 (6)
- ◯ 6 (7)
- ◯ 7 (8)

C.24. I would like to excite my students about their part in this approach.

- ◯ 0 (1)
- ◯ 1 (2)
- ◯ 2 (3)
- ◯ 3 (4)
- ◯ 4 (5)
- ◯ 5 (6)
- ◯ 6 (7)
- ◯ 7 (8)

C.25. I am concerned about time spent working with nonacademic problems related to the C2032 Challenge.

- ○ 0 (1)
- ○ 1 (2)
- ○ 2 (3)
- ○ 3 (4)
- ○ 4 (5)
- ○ 5 (6)
- ○ 6 (7)
- ○ 7 (8)

C.26. I would like to coordinate my effort with others to maximize the C2032 Challenge effects.

- ○ 0 (1)
- ○ 1 (2)
- ○ 2 (3)
- ○ 3 (4)
- ○ 4 (5)
- ○ 5 (6)
- ○ 6 (7)
- ○ 7 (8)

C.27. I would like to know what the use of the C2032 Challenge will require in the immediate future.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

C.28. I would like to have more information on time and energy commitments required by the C2032 Challenge.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

C.29. I would like to know what other faculty are doing in this area.

- ○ 0 (1)
- ○ 1 (2)
- ○ 2 (3)
- ○ 3 (4)
- ○ 4 (5)
- ○ 5 (6)
- ○ 6 (7)
- ○ 7 (8)

C.30. Currently, other priorities prevent me from focusing my attention on the C2032 Challenge.

- ○ 0 (1)
- ○ 1 (2)
- ○ 2 (3)
- ○ 3 (4)
- ○ 4 (5)
- ○ 5 (6)
- ○ 6 (7)
- ○ 7 (8)

C.31. I would like to determine how to supplement, enhance, or replace the C2032 Challenge.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

C.32. I would like to use feedback from students to change the program.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

C.33. I would like to know how my role will change when I am using the C2032 Challenge.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

C.34. Coordination of tasks and people is taking too much of my time.

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)

C.35. I would like to know how the C2032 Challenge is better than what we have now.

- ○ 0 (1)
- ○ 1 (2)
- ○ 2 (3)
- ○ 3 (4)
- ○ 4 (5)
- ○ 5 (6)
- ○ 6 (7)
- ○ 7 (8)

Appendix D

Creativity Questionnaire

Creativity questionnaire formatted as open-ended questions in the pre/post program survey.

1. How do you define teacher creativity?
2. Can we increase creativity, or are you just born with or without it?
3. Are individuals or groups more creative when working on a project?
4. Are people creative in many areas or only in a few specific content areas or tasks? In other words, does creativity generalize?
5. How does teacher evaluations influence creativity?
6. What is the relationship between classroom constraints and creativity?
7. Is it important to market your creativity? In other words, is it important to get others to accept your creativity? Why or why not?
8. How effective are creativity techniques in the design process, such as defining a problem, brainstorming, prototyping, etc.?
9. How do incidents of failure impact teachers as they work toward a change in practice.
10. How important is creativity to teachers when challenged to adopt something new in the classroom?

Appendix E

Workshop Survey

Q1 Overall, how satisfied or dissatisfied were you with this workshop?

- ○ Extremely satisfied (1)
- ○ Moderately satisfied (2)
- ○ Slightly satisfied (3)
- ○ Neither satisfied nor dissatisfied (4)
- ○ Slightly dissatisfied (5)
- ○ Moderately dissatisfied (6)
- ○ Extremely dissatisfied (7)

Q4 How well did the instructor facilitate your understanding of workshop material?

- ○ Extremely well (1)
- ○ Very well (2)
- ○ Moderately well (3)
- ○ Slightly well (4)
- ○ Not well at all (5)

Q2 How interesting was this workshop?

- ○ Extremely interesting (1)
- ○ Very interesting (2)
- ○ Moderately interesting (3)
- ○ Slightly interesting (4)
- ○ Not interesting at all (5)

Q3 How clear or unclear was the presentation of workshop material?

- ○ Extremely clear (1)
- ○ Moderately clear (2)
- ○ Slightly clear (3)
- ○ Neither clear nor unclear (4)
- ○ Slightly unclear (5)
- ○ Moderately unclear (6)
- ○ Extremely unclear (7)

Q6 How much do you feel you learned from this workshop?

- ○ A great deal (1)
- ○ A lot (2)
- ○ A moderate amount (3)
- ○ A little (4)
- ○ Nothing at all (5)

Q5 How satisfied or dissatisfied were you with your effort in the workshop?

- ◯ Extremely satisfied (1)
- ◯ Moderately satisifed (2)
- ◯ Slightly satisfied (3)
- ◯ Neither satisfied nor dissatisfied (4)
- ◯ Slightly dissatisfied (5)
- ◯ Moderately dissatisfied (6)
- ◯ Extremely dissatisfied (7)

Q7 What did you like most about this workshop? Be as specific as possible, and list as many aspects as you feel are appropriate.

Q8 What did you like least about this workshop? Be as specific as possible, and list as many aspects as you feel are appropriate.

Q9 Have you experienced any change in feelings toward the C2032 Challenge? If so, please describe.

Appendix F

Process Evaluation Survey

This short survey monitors progress in the C2032 Challenge.

By participating in the questions below, you signify your consent for the survey. Your responses are voluntary, and your identity will be kept confidential. The information gathered will be compiled together, and what you share will remain anonymous.

All questions address your participation in the C2032 Challenge.

The survey will take approximately 5 minutes to complete, and you are free to stop at any time.

Q1. Did you complete the C2032 pre-program questionnaire?

○ Yes (1)

○ No (2)

○ Can't Remember (3)

Q2. As covered in our first workshop, Choose a Destination refers to actions that clarify problems. An outcome of this process is a problem-statement that identifies how technology can be used to address a problem of practice. Submit your latest problem-statement below, or state "I don't have one yet"

Q3. As covered in our second workshop, Chart a Course considers actions that generate and select ideas to address a problem of practice using new technology. Approximately how many ideas have you generated during the past two weeks?

○ 0 ideas (1)

○ 1-3 ideas (2)

○ 4-7 ideas (3)

○ 8-10 ideas (4)

○ 11 ideas or above (5)

Q4. As covered in our third workshop, Course Correct considers actions that explore and refine existing ideas to address a problem of practice using new technology. Describe an idea that you are actively exploring, or have explored, during the past two weeks.

Q5. During the past two weeks did you prototype this idea, or an aspect of this idea, with students in the classroom?

- ○ Yes (1)
- ○ No (2)

Q6. Excluding prototyping, please list any other design-based strategies that you have deployed as an action to generate or explore an idea in response to the C2032 Challenge? (e.g., looking for ideas on the Internet, brainstorming, speaking with colleagues, etc.).

Q7. Please describe any incidents of failure that have taken place during the past two weeks. These incidents should relate to your participation in the C2032 Challenge.

Q8. Have you experienced any changes in feelings toward the C2032 Challenge? If so, please describe.

Appendix G

Self-Assessment Survey

This self-assessment survey is part of a study to investigate teacher creativity using new technology.

By participating in the questions below, you are signifying your consent for the survey. Your responses are voluntary, and your identity will be kept confidential. The information gathered will be compiled together, and what you share will remain anonymous.

The survey will take approximately 10 minutes to complete, and you are free to stop at any time. The information gathered will be used to compare the outcomes of the C2032 Challenge by group.

Q1 What was your group?

○ Christine's Group (1)

○ Matthew's Group (2)

Q2 What new technology did you use?

2A: Technology 1

____

2B Technology 2 (if applicable)

____

2C Technology 3 (if applicable)

____

Q3 What existing technology did you use?

3A Technology 1

____

3B Technology 2 (if applicable)

____

3C Technology 3 (if applicable)

____

Q4 Please describe the situation or activity as it existed before the C2032 Challenge.

____

____

Q5 What changes [or planned changes] took place as a consequence of the C2032 Challenge?

____

____

Q6 Do you consider the outcome produced from the C2032 Challenge new and useful when compared to the existing practice enacted before?

○ Yes (1)

○ No (2)

Q7 In a short paragraph, explain why you did or didn't consider the outcome produced from the C2032 Challenge new and useful when compared to the existing practice enacted before?

____

____

Q8 Do your peers consider the outcome produced from the C2032 Challenge new and useful when compared to the existing practice enacted before?

○ Yes (1)

○ No (2)

Q9 In a short paragraph, explain why your peers did or didn't consider the outcome produced from the C2032 Challenge new and useful when compared to the existing practice enacted before?

____

____

Q10 Is there evidence that the change was enacted by anyone else in your school?

○ Yes (1)

○ No (2)

Q11 Do your peers plan to implement this change in their practice?

○ Yes (1)

○ Maybe (2)

○ No (3)

Appendix H

Challenge Rubric

Mini-C Outcome	
Do you consider the outcome produced from the C2032 Challenge new and useful when compared to the existing practice that you enacted before?	
Yes (1-point)	**No (0-point)**
As a consequence of participating in the C2032 Challenge, you have introduced a change in practice when compared to what took place before under similar conditions. You consider this change as not only new but something that has led to a valued outcome from the perspective of teaching and learning.	Perhaps there are some elements of novelty or usefulness to the experience produced, but the outcome has not led to a change in practice when compared to what took place before under similar conditions. Instead, the novelty or usefulness supports an existing practice as opposed to a different teaching or learning experience.
	SCORE:

Little-C Outcome

Do you consider the outcome produced from the C2032 Challenge new and useful when compared to other similar practices commonly enacted at the school?

Yes (1-point)	No (0-point)
As a consequence of participating in the C2032 Challenge, you have introduced a change in practice that is new and different when compared to other strategies commonly deployed at the school under similar conditions. You consider this change as not only new but something that has led to an outcome that other colleagues in your community will recognize as having a value from the perspective of your teaching and learning context.	Although others might see there are some elements of novelty or usefulness to the experience produced, few will perceive the outcome as a change in practice that is new and different when compared to other strategies commonly deployed at the school. Instead, most will likely see the newness or usefulness as something to support existing methods deployed under similar conditions.
	SCORE:

Little-C/Pro-C Outcome

Is there evidence to support a belief that the outcome produced from the C2032 Challenge has begun to challenge existing practices commonly shared within the school community and beyond?

Yes (+1-point)	Yes (+1 another point)	No (0-point)
As a consequence of participating in the C2032 Challenge, you have introduced a change in practice that is new and different when compared to other strategies commonly deployed at the school under similar conditions. Evidence suggests this change is valued to such an extent that it is now being adopted or explored by others in the school community. This information might come from references or questions from colleagues who are working toward replicating the outcome in another classroom or requests from administrators to share your outcome with the broader community.	Further evidence suggests the outcome you produced as a consequence of the C2032 Challenge is being adopted or explored by others outside the school community. This information might come from references or questions received from social media, blogging platforms, or external emails. Alternatively, it might come through requests you've received from outside agencies to show your outcome outside the school community. Outside agencies could be at the district level or state level, or they might come from other professional networks where you belong.	Even if perceived as achieving mini-c or little-c, there is little evidence to suggest the outcome is being explored or enacted beyond your practice.
		SCORE:

Appendix I

Workshop Summary

<table>
<tr><td colspan="2">

C2032: Design the Future
Program Outline

Main Objective: Design a creative outcome using a new application associated with the G-Suite

</td></tr>
<tr><td>

Orientation:
(30-minutes)

</td><td>

Objective 1: Summarize the C2032 Challenge

Participants will receive an overview of the C2032 program, including information about the challenge and the corresponding study.

> **Introduction:** Present the goals of the C2032 program and introduce the C2032 challenge.
>
> **Main:** Present the timeline for workshops and introduce the corresponding study; including data collection methods. Participants will be informed that the study component of the program is not mandatory.
>
> **Plenary:** Participants will work in small groups to summarize their understanding of the study and generate questions in response to the information shared during the orientation.

</td></tr>
<tr><td>

Introduction:
(90-minutes)

</td><td>

Objective 2: Associate the concept of a creative outcome within a teacher's professional environment

Objective 3: Describe the concept of killer apps within Google products and explain how they disrupt society

Participants will revisit the expectations of the challenge and have an opportunity to ask questions. They will then receive an overview of Creativity, including how this concept is situated within a teacher's professional environment.

Participants will then engage in an activity to identify a killer app from Google and explain how it disrupted education or society.

> **Introduction:** Revisit the goals of the C2032 program and the C2032 challenge. Highlight the words, creative outcome and application, within the challenge statement. Have teachers work in small groups to associate these concepts within their professional environment.
>
> **Main:** Provide an overview toward the concept of a 'killer app'. Ask teachers to identify a Google product that they consider to be

</td></tr>
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	a killer app. Working in groups, write down everything they know about that application. Then explain why it is a killer app based on how we behaved before and after its diffusion in society. **Plenary:** Connect the concept of a killer app to big-C and pro-C creativity. Then work back toward the concept of little-C and mini-C creativity. Introduce a list of applications available within the G-suite platform and inform participants that they are ultimately challenged to identify their future killer app in the classroom.	
	Treatment Group	**Comparison Group**
Workshop 1: (50-minutes)	**Choose Destination** **Objective 4A: Present a list of problems of practice experienced by teachers in the school** Participants will receive a 10-15-minute presentation on the concept of ill-defined problems, and how a design-based approach can assist them when addressing this challenge. The introduction of new technology will be presented as an ill-defined problem. Participants will work in small groups to explore problems in their practice. At the end of the workshop, participants will present a list of problems and group them by those specific to an individual or department, and those that can be generalized across the school.	**Alternative 1** **Objective 4B: Present a list of technologies to explore for the C2032 challenge** Participants will receive a 10-15-minute presentation from the school's media library specialist. The media library specialist will provide an overview of applications available from the G-Suite, including those commonly used in the school. Participants will work in small groups to share what they know of the G-Suite. Participants will group apps based on "themes" that relate to subject or instruction. For example, a theme might be math, or alternatively it might be visual presentation. At the end of the workshop, participants will present the outcome of this activity.
Workshop 2: (50-minutes)	**Chart Course** **Objective 5A: Produce a problem-statement for the C2032 Challenge** Participants will receive a 10-15-minute presentation on the concept	**Alternative 2** **Objective 5B: Judge a selection of outcomes based on their level of creativity using the C2032 challenge rubric** Participants will receive a 10-15-minute presentation toward the

	of divergent and convergent thinking, and how this contributes to a design-based approach that can assist them when addressing the C2032 challenge. Participants will receive an overview of a problem-statement, presented as a tool to support convergent thinking. Participants will then revisit problems identified from the previous session and engage in divergent and convergent thinking to produce a problem-statement they can present to the group. At the end of the workshop, participants will be asked to work on problem-statements relevant to the C2032 challenge.	concept of a creative outcome in respect to the challenge rubric. Participants will work in small groups to review a collection of vignettes that illustrate outcomes produced by teachers challenged to use new technology. Groups will judge outcomes based on their level of creativity using the challenge rubric. Groups will share their judgements for discussion by the wider group. At the end of the workshop, participants will be challenged to connect some of the technologies explored in the previous session to ideas they consider to be creative.
Planning Day (60-minutes)	Participants will work on the C2032 Challenge as individuals or in small groups. There is no formal activity for this session. THIS SESSION DID NOT TAKE PLACE	Participants will work on the C2032 Challenge as individuals or in small groups. There is no formal activity for this session. THIS SESSION DID NOT TAKE PLACE
Workshop 3: (50-minutes)	INTERVENTION TOOK PLACE BEFORE THIS WORKSHOP. CONSEQUENTLY, THERE WAS ONLY 40-MINUTES FOR THIS ACTIVITY) **Course Correct** **Objective 6A: Describe incidents of professional failure that supported long-term professional growth** Participants will receive a 10-15-minute presentation on the concept of turning experimental failures into learning experiences. Participants will then be given three questions to explore; do we fear failure as teachers in the classroom? How do we know if a	INTERVENTION TOOK PLACE BEFORE THIS WORKSHOP. CONSEQUENTLY, THERE WAS ONLY 40-MINUTES FOR THIS ACTIVITY) **Alternative 3** **Objective 6A: Discuss ideas for the C2032 challenge and convince colleagues why it constitutes as a creative outcome** Participants will receive a 10-15-minute presentation on a colleague's progress in the C2032 Challenge. Participants will work in small groups to discuss how this idea relates to other ideas in the group.

	new idea has potential? In what ways can we monitor our learning from failure? Each question will be discussed in small groups for 5-7 minutes, and then discussed again as part of a larger group. Participants will be challenged to experiment with ideas in response to the problem-statement, while using incidents of failure as opportunities to modify or change their idea.	Once a connection has been made, the group will work to justify why this idea constitutes as a creative outcome. At the end of the workshop, participants will be challenged to explore these ideas further, and consider how they might relate within the context of their own practice.
Workshop 4: (50-minutes)	**Reflect** **Objective 7A: Differentiate between internal and external feedback loops** Participants will receive a 10-15-minute presentation that recaps the C2032 Challenge, including information about creative outcomes. They will also receive an overview toward the concept of an internal and external feedback look. Participants will reflect on their practice and consider how they judge weather an outcome they've produce is successful. Do they actively solicit and reflect on external feedback from students, colleagues, and administrators? Or do they prioritize their perspective. Participants will receive an overview of what is expected for the plenary and asked to consider how they evaluate outcomes produced from the C2032 challenge.	**Alternative 4** **Objective 7B: Evaluate ideas presented by colleagues** Participants will receive a 10-15-minute presentation that recaps the C2032 Challenge, including information about creative outcomes. Participants will work in small groups to evaluate their ideas based on whether it addresses the expectation of the C2032 Challenge. Suggestions and improvements will be made. After the group activity, individuals will be invited to share their idea with the larger group and communicate what improvements were suggested by colleagues. Participants will receive an overview of what is expected for the plenary.
Open Session (90-minutes)	Participants will work on the C2032 Challenge as individuals or	Participants will work on the C2032 Challenge as individuals or in small

	in small groups. There is no formal activity for this session. THIS SESSION WAS ORGANIZED IN RESPONSE TO A REQUEST FOR MORE TIME TO WORK ON THE CHALLENGE	groups. There is no formal activity for this session. THIS SESSION WAS ORGANIZED IN RESPONSE TO A REQUEST FOR MORE TIME TO WORK ON THE CHALLENGE
Plenary: (60-minutes)	**Plenary** **Objective 6A: Conduct a self-assessment to evaluate outcomes produced for the C2032 Challenge** Participants will receive a 10-minute presentation that presents guiding questions to help facilitate a peer-assessment of outcomes produced for the C2032 Challenge. Participants will be grouped in teams of three and organized by departments. In these small groups they will dedicate 15-minutes to each idea presented in the group. At the end of this discussion, individuals will be invited to complete a self-assessment survey to present an evaluation of weather they consider their outcome creative based on their discussion with colleagues.	

Appendix J

Internal Rubric to Measure Outcomes

Mini-C Outcome	
Do you consider the outcome produced from the C2032 Challenge new and useful when compared to the existing practice that you enacted before?	
Yes (1-point)	**No (0-point)**
As a consequence of participating in the C2032 Challenge, you have introduced a change in practice when compared to what took place before under similar conditions. You consider this change as not only new but something that has led to a valued outcome from the perspective of teaching and learning.	Perhaps there are some elements of novelty or usefulness to the experience produced, but the outcome has not led to a change in practice when compared to what took place before under similar conditions. Instead, the novelty or usefulness supports an existing practice as opposed to a different teaching or learning experience.

Appendix K

Google doc used to guide self-assessment

To conclude the C2032 program, you will work with colleagues to discuss your participation in the C2032 Challenge.

To support this conversation, follow the steps below.

You have approximately ten-minutes to discuss each idea. Make notes of your conversation using this template. This will help complete the self-assessment form toward the end of the workshop.

- **STEP 1:** Review C2032 Challenge and Rubric
- **STEP 2:** Complete the table below for each idea
- **STEP 3:** Use this information to complete the self-assessment survey

IDEA 1:
List new technology used: • Technology 1: • Technology 2: (or state N/A) • Technology 3: (or state N/A)
List existing technology used: • Technology 1: • Technology 2: (or state N/A) • Technology 3: (or state N/A)
Please describe the situation or activity as it existed before the C2032 Challenge. • Record conversation here (bullet points are fine)

What changes [or planned changes] took place as a consequence of the C2032 Challenge? • Record conversation here (bullet points are fine)
Do you consider the outcome produced from the C2032 Challenge new and useful when compared to the existing practice enacted before? [Explain why or why not] • Record conversation here (bullet points are fine)
Do your peers consider the outcome produced from the C2032 Challenge new and useful when compared to the existing practice enacted before? [Explain why or why not] • Record conversation here (bullet points are fine)
After discussing your idea do your peers plan to experiment with this change in their practice? • Yes or no?
Is there evidence that the change was enacted by anyone else? • Yes or no?

Matthew Worwood

PERSONAL SUMMARY

- Associate Director of Digital Media Design at the University of Connecticut
- Graduate of Fairfield County Leadership Program (2019)

EDUCATION

- **John Hopkins University, MD**
  Doctor of Education (Technology and Design)
  Summer, 2020
- **Central Connecticut State University, CT**
  Master's of Science (Education, concentration in Creativity)
  Summer, 2013
- **Roehampton University, Surry UK**
  Post Graduate Certification in Education (Early Years)
  Summer, 2005
- **City University, London UK**
  Bachelor of Arts (Drama)
  Summer, 2003

EMPLOYMENT

University of Connecticut, Digital Media Design, CT
July 2013 – present

Associate Director, Digital Media Design/Assistant Professor in-residence

Center for 21st Skills, Ed Advance, CT
October 2008 – July 2013

Digital Media Specialist/Director of Connecticut Student Film Festival

Stepney Green Coats Primary School, London UK
August 2004 – July 2006

First Grade Teacher

HIGHLIGTED WORKS

- Worwood, M. J. (Producer & Director). (2019). Class of 2032: Schooling for a Digital Culture. Amazon Digital Services. Retrieved from https://www.amazon.com/Class-2032-Schooling-Digital-Culture/dp/B07PYSFBF4/ref=sr_1_fkmrnull_1?keywords=Class+of+2032%3A+Schooling+for+a+Digital+Culture&qid=1553523264&s=gateway&sr=8-1-fkmrnull
- Thompson, J., W. & Worwood, M. J. (2018). Cass of 2032 (1) [Mobile application software].

Retrieved from https://play.google.com/store/apps/details?id=com.classof2032.app&hl=en_US

- Worwood, M. J., & Plucker, J. (2018). Domain Generality and Specificity in Creative Design Thinking. In Darbellay, F., Moody, Z., Lubart, T. (Eds.), Creativity, Design Thinking and Interdisciplinarity, (pp. 83-91). Singapore: Springer
- Worwood, M. J. (2017). Class of 2032: Considerations for today and tomorrow. Presented as keynote at the Cradle to Career annual summit, Dec. 7, 2017, Stamford, CT.
- Worwood, M. J., & Olschan, S. (2014). Class of 2032. NMC five minutes of fame. Presented at the New Media Consortium annual conference, June. 11, 2015, Washington, DC.
- Worwood, M. J. (Producer & Director). (2019). Class of 2032: Schooling for a Digital Culture. Amazon Digital Services. Retrieved from https://www.amazon.com/Class-2032-Schooling-Digital-Culture/dp/B07PWJ7N1C
- LaBanca, F., Worwood, M. J., Schauss, S., LaSala, J., & Donn, J. (2013). Blended Instruction: Exploring student-centered pedagogical strategies to promote a technology-enhanced learning environment. Litchfield, CT: EdAdvance
- Worwood, M. J. Creativity in Education: Going Beyond Expectations. Presented as keynote at the Aldrich Art Museum: Creativity Seminar, Apr. 4, 2013, Ridgefield, CT.
- Worwood, M. J. & LaBanca, F. (2012) The 10-cube challenge: using virtual worlds to foster creative thinking. Journal of Immersive Education. Boston: Mass. Retrieved from http://jied.org/

GRANTS

- CT Next CoAction Lab 2020, $80,000
- Making Connections to Industry: A Micro-Course for CT College Students, 2020, $149,960
- Making Connections: Establishing a CT Digital Media Pipeline: 2019, $149,800
- UConn Stamford CoAction Lab 2019, $26,100
- Growing up in a Digital Culture: Children, Parents, and Technology: 2018, $12,500
- Making Connections: Establishing a CT Digital Media Pipeline: 2018, $154,324
- University of Connecticut, Teaching Innovation Mini Grant: 2015, $3,431
- Class of 2032: 2015. $3,500
- Connecticut Inter-District Cooperative Grant Program: 2013, $133,647. 2014, $125, 241
- Connecticut Inter-District Cooperative Grant Program: 2011, $134, 471. 2014, $115,660

RECOGNITIONS

- CT Education Entrepreneur of the Year, 2020 (finalist)
- Faculty Recognition Award 2019, University of Connecticut, Stamford Campus
- NMC Innovation Zone Recognition Award, 2017
- Apple Distinguished Educator Award, 2011